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EXPERIENCE IN THE TREATMENT OF BRAIN TUMORS BY IRRADIATION DURING THE PAST THIRTEEN YEARS*

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NUMEROUS reports have been made during the past few years on the results of treatment of brain tumors by irradiation. While this method of treatment is comparatively new, it is a noteworthy fact that a large number of cases have been subjected to roentgen-ray and radium therapy. This would be expected from an experimental standpoint, at least, when we consider that the operations for removal of brain tumors are hazardous in many instances, many growths can be only partly removed, and still a large percentage are inaccessible for removal. On the other hand, irradiation has been successful to a certain extent in the treatment of localized tumors elsewhere in the body, and it has been proven that a normal brain tissue surrounding does not contraindicate the use of deeply penetrating roentgen rays and gamma rays of radium in large doses.

The reports so far made represent individual efforts and results with widely varying techniques. At the same time, however, a sufficient time has elapsed following the treatment of a large enough group of cases for all those who have been engaged in this work to offer their data for comparison, analysis and study, or even criticism. In this way our experiences may be to our mutual benefit, and it may be possible to form a comprehensive opinion in the near future of the real merits of radiation therapy, if there are any. This method is passing through the same stage of experiment, varying results, over-enthusiasm and criticism, both just and unjust, that has characterized the development of radiation therapy in nearly all other conditions. Sometimes faulty technique will explain varying results and the unjust criticism entailed, and, collectively, we may be able to correct the faults by mutual discussion. The treatment of brain tumors is likely to create either over-enthusiasm or disappointment, both of which must be curbed if we wish to reach any conclusions of value. Any neurosurgeon is quite willing to welcome this adjunct to surgery if we can prove to him that it has definite value, but such a value still remains to be proven. If it does not exist, both the surgeon and the radiologist are willing to drop the matter.

While we cannot prove very much as to the value of irradiation without discussing results of treatment more or less in detail, the main object of this presentation

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is to discuss methods and to attempt to show that many radiologists are probably not working along the proper lines. Comparisons of results of various individuals, and even of our own early and late cases, may give further proof of this, and after a standardization of technique, we may all be in a better position to make good use of our collective data.

Most of the cases we have treated have been referred from the Neurosurgical Service of Dr. Charles H. Frazier, to whom we were indebted for the privilege of the statistical report on cerebellar cases treated up to 1926, herein referred to later, and presented before the 1926 meeting of the Association for Research in Nervous and Mental Diseases.[1] It was our original intention to include statistics of the cerebral tumors in this presentation and to compare the results in the two groups, but this has not been feasible, as will be explained later. Results in the pituitary group will not be included, as it is hoped that a later report of the cases will follow. They will be discussed as a group simply from the standpoint of technique, particularly because of radical changes recently made in the method of treatment.

In a previous communication in 1922,[2] thirty-two cases of intracranial tumors treated by irradiation were reported, and with a single exception, all of them were treated with radium alone, by implantation, external crossfire irradiation or both. Since 1923, deep roentgen-ray therapy has been the sole method of treatment. The reasons for changing our method will be discussed later. From 1914 to the end of 1926, 136 cases of intracranial tumors were treated, divided as follows:

Pituitary tumors	46
Cerebral tumors	42
Cerebellar tumors	48

No unusual results are claimed in the treatment, with possibly a very few exceptions, and we freely acknowledge our shortcomings, which have frequently become quite apparent. From a conservative point of view, the results, as a whole, have been disappointing in many respects. In many instances, however, surprisingly satisfactory temporary results and a few more permanent ones have created an enthusiasm that has stimulated a continuance of the work. In a general way we feel that our experience, together with that of others, indicates a very definite and important future for irradiation in the treatment of some brain tumors and pituitary growths, though by no means all of them.

The pathological analysis of the 48 cerebellar tumors was as follows:

Gliomata, infiltrating	10
Gliomata, cystic	5
Neurofibromata	1
Endotheliomata	4
Unclassified, no section taken	14
Tumor not found at operation, and localized for treatment on clinical evidence alone	12
Not operated, but treated by x-ray	2
	48

RESULTS OF TREATMENT

The following analysis shows the results of treatment of the 48 cases of cerebellar tumors:

Living	25
Dead (known)	12
Cases discarded (because of lack of sufficient data)	6
Outcome uncertain (no follow-up)	5
	48

In the following table (Table 1) of cases living and dead, all of the cerebellar tumors classified as pathological entities were proven by biopsy or following autopsy. A few of the gliomata were further classified as different members of this group, but as many of them were not, we have classed them all as gliomata.

TABLE 1

	Number of Cases	Glioma Cystic	Glioma Infiltrating	Neurofibroma	Endothelioma	Unclassified	Not Found at Operation	Not Operated
Living:								
One year or less	10	..	2	..	2	2	2	2
One to 2 years	2	..	..	1	..	1	..	..
Two to 3 years	5	..	2	..	1	2	..	..
Three to 5 years	2	..	..	..	..	1	1	..
Five to 7 years	4	..	1	..	..	2	1	..
Twelve to 13 years	1	..	1	..	..	..	..	..
Thirteen years	1	..	..	..	..	..	1	..
Total	25	0	6	1	3	8	5	2
Dead, or outcome uncertain after period stated:								
Lived less than 1 year	11	2	2	..	..	3	4	
Lived 1 to 3 years	7	2	2*	..	..	2	1	
Lived 3 to 5 years	4	1	..	..	..	1	2	
Lived 12 to 13 years	1	..	..	..	1†	..	..	
Total	23	5	4	0	1	6	7	

At the time of our recent report[1] on the results of treatment in the cerebellar group of tumors, attention was called to the fact that we rather anticipated a somewhat better showing in the cerebral group when they were worked up because we thought that most lesions of the latter class had received more intense radiation as a rule. We attempted to complete the statistics of the cerebral tumors in order to compare the two groups, but we were unable to compile any satisfactory ones. Furthermore, we have failed to find any indications of our previous expectations, and in fact, the results in the cerebral tumors have apparently not been so favorable as in the cerebellar cases. One explanation is to be found in the fact that the older cases in the latter group made the best showing, whereas for some reason not at the moment apparent, only 2 cerebral tumor cases were treated prior to 1920. In fact, the majority have come to us during the past two years.

Out of 42 cerebral cases treated, we have been obliged to discard 25 for several reasons, viz: insufficient data for statistical purposes; refused further treatment or stopped treatment for other reasons; died before completing a series or after a series was completed or treated for supposed brain tumor at first and the diagnosis later changed to some other condition, as lead poisoning, insanity, arachnitis or paresis. To sum up, no good results with any permanency were obtained in any type of lesion among the cerebral tumors with the single exception that a patient with cystic glioma lived five years, which is rather unusual. Three calcified cerebral tumors were treated, all endotheliomata, but the results were not satisfactory.

In the interpretation of statistics, it should be borne in mind that an operation may be responsible for some of the results ascribed to irradiation. In cerebellar tumors, especially, the operation is in itself a decompression, which must be held accountable for some of the initial or early improvement noted in operated cases treated, and may be responsible for the entire result ascribed to subsequent irradiation. When there is a recurrence of symptoms some time after operation and evidences of definite increase of pressure, and the symptoms and pressure are relieved by subsequent treatment, we have much better evidence of the efficacy of the radiation therapy. Repeated recurrences followed each time by subsidence of symptoms after a series of treatment applications have been noted by us frequently, and we feel that in some of the cases, at least, this can safely be regarded as evidence of the effect of the irradiation, which is not quite sufficient to destroy the tumor.

It will be noted in Table 1 that most cases of cystic glioma died at a comparatively early period, although one cerebellar case lived for over five years, and the one cerebral case above mentioned, lived nearly five years. As would be expected, the infiltrating glioma made a somewhat better showing. One cerebellar case is still alive over five years, and one is still living after thirteen years. This last case received a heavy implantation dose of radium (platinum filtration and gamma rays) into a solid cerebellar tumor, none of which was removed except a section for biopsy. Subsequently, four series of external radium applications were made up to 1920. He has remained blind and very ataxic. In 1921, he was reoperated upon because of a recurrence of pressure symptoms. A large cyst was found at the site of the original tumor. This was evacuated, and a section removed from the cyst wall showed no tumor tissue.

It is unfortunate that our longest living case is rather useless for statistical purposes, as no tumor was found at operation. The patient was operated upon by Dr. Frazier in 1913 for a supposed cerebellar tumor. A suboccipital craniotomy was performed, and a section removed from a suspicious area showed normal cerebellar tissue. Nevertheless, the case was treated on the basis of a brain tumor and received seven external radium applications from 1915 to 1920. The patient is still living, and barring some unsteadiness in gait, is fairly healthy and comfortable. Certainly there is no reason to withhold treatment in cases such as this one simply because the tumor is not found. If there is good presumptive evidence that a growth is present, there can be no objection to irradiation on the basis of clinical evidence. As a matter of fact, it is in just this type of case that radiation

therapy is perhaps most valuable from the therapeutic standpoint, although it is of little value from the scientific point of view because it cannot be used for statistical purposes, especially in the endeavor to determine the effects of irradiation upon tumor entities. Unfortunately, we are frequently handicapped in such cases because of our inability to place our depth dose properly.

Two of the patients who died (see Table 1) exhibited widespread distant metastases by roentgen examination before death. They are of peculiar interest for this reason and have been reported elsewhere.[3] One of them' had a cerebellar endothelioma, and was our first brain tumor case to receive radiation therapy, early in 1914. She was operated upon by Dr. Frazier in February, 1914, and about seven-eighths of a tumor was removed. The pathologist's report was endothelioma. She received postoperative roentgen-ray treatment in 1914, and external radium irradiation in 1915, and was fairly comfortable for two years, when the cerebellar symptoms recurred. The second operation in 1917 revealed a recurrence with marked extension. Much of the tumor was removed, and radium was implanted. Subsequently four series of external radium and deep roentgen-ray applications were given and the patient was kept fairly comfortable until August, 1926, when a roentgen-ray examination showed metastasis to the lungs and she died shortly afterwards.

The second metastatic case* (see Table 1) had three operations, one in November, one in December, 1919, and the third in January, 1920, at none of which was a tumor found. At a fourth operation in January, 1921, a large cerebellar tumor was discovered and was removed fragmentarily. Radium was implanted and subsequently external radium irradiation was applied three times. In October, 1923, a roentgen-ray examination to determine the cause of severe pain revealed extensive bone metastases in the lumbar spine and pelvis. A cordotomy was performed to relieve the pain, and the patient died three months later. Section of the brain tumor showed glioma (medullary blastoma).

It is unfortunate that no autopsy was permitted in either of these cases. While no other primary tumor could be found elsewhere to account for the metastases, we realize that we cannot be certain that the brain lesion was the primary focus in either instance. While brain tumors do not seem to metastasize, judging by the lack of reports in literature, we can see no reason why occasional blood stream metastases should not occur, especially when the tumors are repeatedly traumatized by operation, partial removal and radium implantations. If patients can be kept alive longer in this manner, there is better opportunity offered for metastasis than formerly.

ADAPTABILITY AND GENERAL INDICATIONS FOR TREATMENT

In our original communication[2] we called attention to the fact that brain tumors are peculiarly adapted to treatment by irradiation for many reasons, which may be summarized as follows:

1. They are usually comparatively slow in growth and rarely metastasize. These are two ideal conditions which are seldom encountered in dangerous regions elsewhere.

2. They can frequently be removed in part with safety and the remaining portion left for irradiation. This is usually regarded as meddlesome and poor surgery in the case of malignant growths elsewhere in the body.

3. The tumor may be exposed and a section taken for biopsy, and if irremovable, it may be left otherwise intact for subsequent irradiation.

4. Even if a clinically localized tumor is not found at operation, the case can still be treated, although at a disadvantage because its exact location and extent are in doubt.

5. In case a tumor is not found, temporary relief of pressure is afforded by decompression, which is a distinct advantage.

6. A large proportion of brain tumors can be regarded as made up of pathologically malignant cells which are frequently more susceptible to irradiation than normal cells.

7. Normal brain tissue seems to be more resistent to the effects of irradiation than many or most of the normal structures surrounding malignant tumors elsewhere.

8. The shape of the head is fairly well adapted to crossfire irradiation and the measurement of depth dosage at tumor sites.

9. In the light of our present knowledge of radiation therapy in brain tumors, this treatment cannot supplant operation and reasonably safe removal. The best that can be hoped for is that irradiation may possibly obviate the more or less dangerous removal of certain proven very radiosensitive types of growths.

A classification of cerebellar cases according to operative procedure permits of the following groups:

Tumor completely removed	8
Tumor partially removed	4
Tumor found but not removed	18
Tumor not found at operation	17
No operation; tumor presumptive	1
	48

In the first group in which the tumors were apparently completely removed, postoperative irradiation was administered as a preventive measure against recurrence in case every vestige of the growth in each instance had not been eradicated. In the fourth group cerebellar tumors were found at autopsy in two cases and not found in one other.

In Groups 4 and 5 we feel that treatment was entirely justifiable. If a tumor cannot be found at operation, or operation is contraindicated or refused, and there is strong clinical evidence that a growth is present, we can see no harm in treating the case, and in a few instances, irradiation has been followed by marked improvement, which, especially in cases not operated upon, could not be ascribed to other cause. Operation is always desirable from the irradiation standpoint because of the beneficial effect of decompression when necessary, the localization and determination of the extent of a growth and the determination of its histological characteristics. One is greatly handicapped by lack of knowledge of localization and pathological identity, but we know from experience that a comparatively large dose of roentgen rays or gamma rays can be administered through a considerable extent of brain tissue without untoward effects. In several cases of lethargic encephalitis, we have exposed a considerable area of the brain to comparatively large doses of deep roentgen rays with no apparent ill effects.

DANGERS

The possible dangers attending the radiation treatment of brain tumors may be considered under several headings, and apply to cerebral, cerebellar or hypophyseal growths.

1. Danger to the skin. The healthy skin of the scalp will stand as much filtered radiation as that of any other portion of the body. Dosage is based upon a skin tolerance unit of the average individual, defined by experience. Fortunately, marked variations in susceptibility are rather uncommon, and cannot be considered when life is at stake.

2. Loss of hair is a necessary consequence of adequate irradiation, and cannot in any possible way be avoided. It is wise to warn the patient, parents or family of this unavoidable result. The hair usually returns, but this cannot be promised or guaranteed. The eyebrows and lashes are always protected as well as possible by lead as a part of the advisable protection to the eye, except when it becomes necessary to make this part of the head a port of entry.

3. Sloughing or delayed healing of the flap. Neither is likely to occur when infection is not present, provided the usual dosage is employed and treatment is not instituted too soon. It had best be delayed until complete healing is apparent and the flap seems to have regained its vitality.

4. Reactions to treatment. Intense irradiation is certain to cause, or be followed by, in many instances, a reaction which is manifest by evidences of increased pressure, especially headache, vomiting or choking of the discs. Immediate cessation of treatment is indicated. We have found that such reactions are seldom apt to occur since we have modified our technique to more nearly a fractional dose method, requiring two or three weeks of daily applications for completion. Hospitalization is advisable in all cerebral and cerebellar cases in order that patients may be carefully watched, and should be insisted upon if much increased pressure exists.

5. Injury to normal brain tissue. As we have previously stated,[2] the technique of radiation therapy must depend to a large extent upon the known ability of normal brain tissue to withstand definite amounts of radiation by whatever means administered. The amount it will stand without injury must be based upon experience and the results of animal experimentation. So far as we have been able to observe, no deleterious effects have followed the administration of a depth dose up to 100 per cent, at or near a tumor site, of a mild erythema dose of well filtered high voltage roentgen rays when slowly delivered. This is not a saturation dose, however. Three ports of entry are necessary to obtain such a depth dose anywhere within the cranial cavity.

It is probable that many brain tumors, like malignant tumors elsewhere, are unusually radiosensitive, others nearly as resistant to irradiation as the surrounding normal tissues and still others, just as resistant or more so. When tumors of the last group become identified by experience of many individuals, it will be known that treatment of them will be futile when they are encountered. Those of the first group, if any exist, should yield excellent results to external irradiation alone, if given in sufficient dosage. In tumors of the second group, this will probably not suffice in itself, and possibly it will be found necessary to return to our old method of radium implantation as a supplementary procedure, but this incurs the added risks of infection and the destruction of normal brain substance. Needles, which require subsequent removal, add greatly to the risk of infection.

Experimental work on dogs carried out in 1920 by Williamson, Brown and Butler,[4] and in 1921 by Pendergrass, Hayman, Houser and Rambo,[5] proved that normal brain tissue will not withstand very large doses of radium by direct depth implantation. They showed that the destruction of comparatively small areas of normal brain by implantation was followed by death of dogs, whereas the animals survived the operative procedure incident to the implantation of small doses insufficent to cause any marked destruction. Implantation doses as small as 360 mg-hr. with filtered radium caused death. The lesson to be learned from this experimental work is that implantations must be kept away from uninvolved brain tissue in tumor cases. One must be very certain that a suspected area is brain tumor tissue before implanting needles or tubes, and their use *is contraindicated when a tumor is very nearly or entirely removed.*

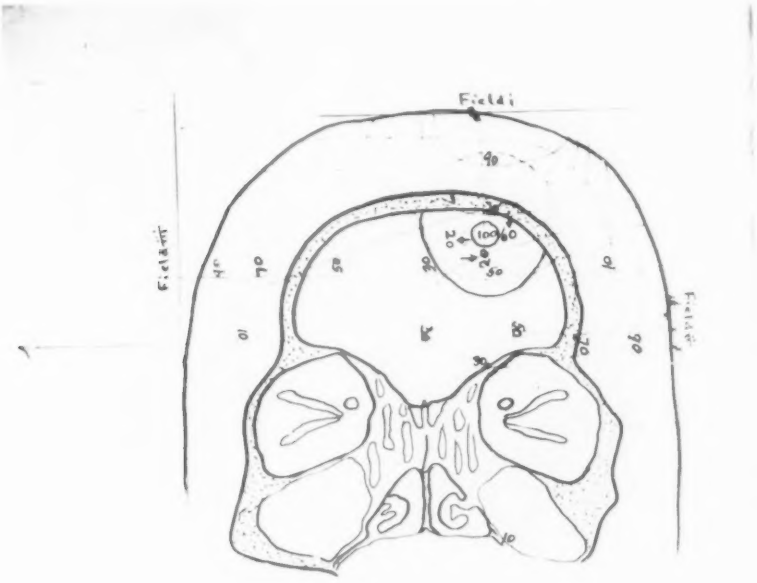
Needles or emanation tubes, to be effectual, must of necessity be implanted somewhere near the actively growing periphery of the tumor, for their direct destructive effect upon the cells in this portion, and partly for crossfire effect upon the central portion of the tumor. The older forms of glass emanation tubes or seeds require the most careful placement and must be implanted sufficiently far away from the periphery of the growth to permit tumor tissue to act as a sufficient filter to protect the normal brain structure against destruction. Implantations in tumors, if employed, must be arranged over an extended area and the dose had best not be entirely destructive to the tumor, but supplemented by external irradiation.

TECHNIQUE

Our first brain tumor patient treated, the cerebellar endothelioma case already referred to as having died with metastases, received low voltage roentgen therapy for the first series of applications in 1914, but was subsequently treated by radium alone, as were all the other cases (20 of the cerebellar group) from 1914 to 1923. In all of these, surface irradiation was employed in every instance, and was supplementary to implantation in 8 cases. Since 1923, all cases (including 28 of the cerebellar group) have received deep roentgen-ray therapy alone. We believe that this method is superior to the employment of radium in smaller quantities, but, from lack of experience, we can offer no objection to the use of the 10 cm. pack containing a large amount of radium or emanation when available.

In our earlier cases treated by high voltage (200 kv.) roentgen rays, we administered a full erythema dose to one side of

the head and a half dose to the other side in cerebral and hypophyseal tumors, and a single wide area over the back of the head in cerebellar cases. Depth dose measurements by the Weatherwax[6] charts showed us that we were not getting anywhere near 100 per cent irradiation at tumor sites in cerebral and hypophyseal growths (Figs. 1 and 2), and we have recently added a third port through the top of the head in order to bring the tumor site dose up to 100 per cent, or very close to it, through 6 × 8 cm. fields (Fig. 3). The futility of attempting to treat pituitary growths by placing radium in the nasopharynx (Fig. 4) was brought to our attention by measuring the approximate dosage at various portions of a pituitary tumor delivered from a radium applicator delivering gamma radiation. With 100 per cent dosage based on a rather severe reaction in the nasopharynx, only about 15 per cent reaches the lower margin of a growth depressing the sellar floor to a considerable extent and about 5 per cent is available at the top of an average sized tumor. The great discomfort created by repeated radium applications in this region with the very slight increment in dosage hardly justifies this older procedure at the present time.



Fields	Date	Daily Dose	Total Surface Dose	Total Tumor Dose	Surface Saturation Dose	Tumor Saturation Dose
i	1-3-37 1-5-37	20%	100%	70%	86%	60%
ii	1-6-37 1-10-37	20%	100%	20%	83%	17%
iii	1-11-37 1-18-37	20%	100%	20%	86%	17%
						94%

FIG. 1. Diagram showing the possible 100 per cent depth dose for deep roentgen rays obtainable at a cerebral tumor site through three 6 × 8 cm. ports as determined by the Weatherwax depth dose charts.

Measurements by the Weatherwax charts in cerebellar cases showed that we

were getting only 40 to 60 per cent of a skin dose into deep cerebellar and angle tumors and 90 per cent to the posterior portions of cerebellar growths through the one posterior port of 8 × 14 cm. field (Fig. 5). This discovery made us decide to change our technique to two small lateral ports of 6 × 8 cm., which permitted a delivery of 50 to 75 per cent dosage throughout the cerebellar areas, except 85 per cent on each lateral aspect. Even this increase did not seem to be sufficient, and lately we have added a third port posteriorly, which raises the dosage to 100 per cent easily, or even to 115 per cent (Fig. 6). There seems to be no danger from secondary radiation between areas when the three ports are used. Sometimes even a little fringe of hair will remain.

Some brain tumors will, of course, not respond even to this dose, while for others it may be more than is necessary. Until such facts are determined by collective experience of all of us, we feel that it is necessary to continue to treat all cases with the maximum possible safe dose. Naturally, lower voltage apparatus and less penetrating roentgen rays cannot possibly create a depth tumor dose of anywhere near the percentages just mentioned, and if such heavy doses are necessary, the low voltage technique will be useless.

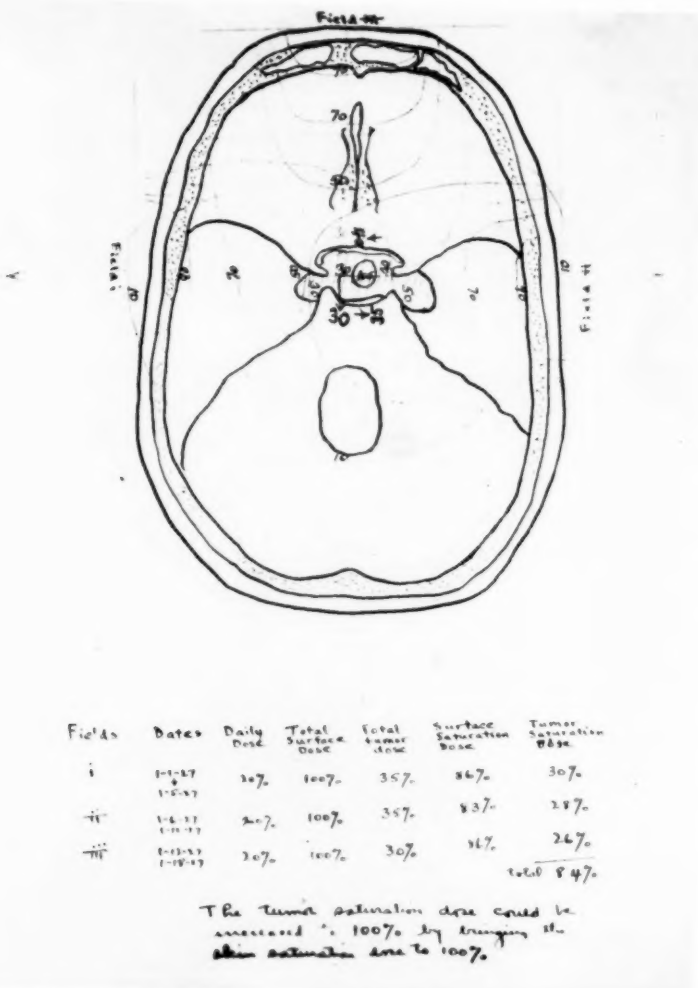


FIG. 2. Diagram showing the possible 105 per cent depth dose obtainable at the pituitary fossa through three 6 × 8 cm. ports.

If larger doses are required in certain tumors, it will be necessary to resort to radium implantations. Possibly it may be necessary for the surgeon to change his technique somewhat in the future if irradiation is to have a thorough trial. It would be much simpler and more conducive to accurate treatment if at the time of operation a tumor is found and cannot be removed, to obtain a satisfactory specimen for biopsy and proceed no further. If the pathological report shows a tumor which requires more irradiation than can be delivered from the outside, a second stage operative procedure might be carried out and implantations made then. This is a far more rational plan for those who do not have direct contact with a radium emanation plant. The decision can be reached at the first stage operation as to how large a dosage will be required and the gold or platinum tubes can be ordered in the quantity and strength needed for the second stage procedure.

Another advantage of making implantations at a subsequent operation is the avoidance, by the protection of a biopsy, of introducing tubes into normal brain tissue, which may cause death. (See dangers.) Applications into normal brain tissue must always be avoided. They are likely to be dangerous in infiltrating growths such as gliomata, unless very carefully placed and will not be as efficacious anyway as in localized tumors. They should never be employed after complete removal of a tumor, as death has been known to occur as a result of this procedure. Great care is imperative if implantations are made near vital centers.

The proper implantation of gold or platinum tubes will demand greater refinements in technique than have yet been practiced, and will require the closest

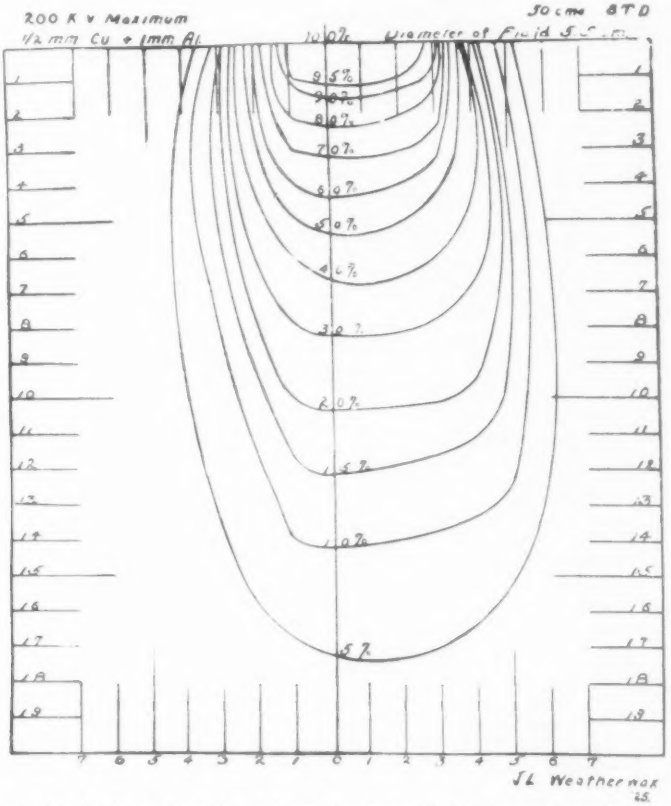


Fig. 3. The Weatherwax depth dose chart for 5.5 cm. fields used for measuring the dosage through our 6 × 8 cm. ports.

co-operation between the surgeon, radiologist and physicist. Tubes must be carefully placed and properly distributed according to a prearranged plan and not on the spur of the moment, hence another reason in favor of a two-stage operation.

We have never been in sympathy with the single or rapid massive dose method of

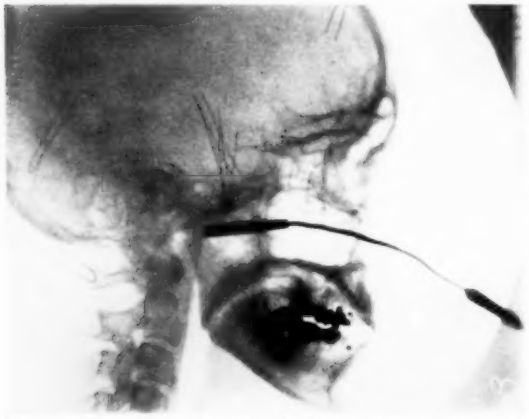


FIG. 4. Case of carcinoma of the pituitary body with radium applicator in position in the nasopharynx. This helped in the old days of low voltage roentgen rays but is unnecessary now.

administering deep roentgen-ray therapy and we have never practiced it in the treatment of brain tumors, as it is undoubtedly dangerous. Plenty of time must be taken in treating such cases. In the beginning, we did treat cases somewhat more rapidly than is our custom at present, and decided evidence of a sudden increase in intracranial pressure was exhibited in several instances. As a result, we insisted that *all* patients should be hospitalized during treatment. We later changed our technique to a fractional dose method which is now being employed. Our dose to any one area is 300 milliampere-minutes, but not more than 40 to 60 ma-min. is given on any one day. Even with this slow progress, we have had to discontinue treatment temporarily on several occasions. Levy[7] and others have called attention to this necessity, especially in connection with the appearance of choking of the discs. We have previously referred to this matter of reactions in connection with the dangers from irradiation. Another reason for adopting the modified fractional dose method was the rather general tendency in recent years to treat all cases of malignancy by that method, with apparently better results.

Our full skin dose over each area treated comprises the following factors: 200 kv., filter of 0.5 mm. copper plus 2.0 mm. aluminum; 50 cm. target skin distance; 4 ma. of current and 75 minutes' time, over a period of four or five days. This dose always causes complete epilation and there is a slight erythema of the scalp occasionally, although the same dose may produce a decided erythema of the skin when applied elsewhere over the body. As previously stated, we have not yet brought this dose up to saturation at a later date. Such a treatment, as described, is usually repeated in six weeks after the entire series is completed, and a third series may be given two months after the second. We can see no justification for giving more than three series, for if a case will not respond to three, it certainly will not to four or more series. Very often a fourth and last series is given six months after the third, or the third is given six months after the second. The size of the fields and their distribution have already been referred to.

Exact localization of tumors is a most essential factor in their proper radiation treatment, which can be carried out to far better advantage when the location and extent of the growth are definitely known. This implies that the necessary knowledge must be gained by finding the tumor at operation. One cannot carry out a satisfactory plan of attack by the proper depth dose otherwise. It is true that we shall have to continue to treat some tumors without operative proof of localization, and it is entirely justifiable and safe, but certainly can never be perfectly satisfactory.

RADIOSENSITIVITY OF TUMORS

The localization of a tumor and the correct technique for its treatment are essential factors in success, but we shall not get very much further than we are now unless we combine with these two factors a third—the determination of the histological characteristics of each growth treated. Anyone who has had much experience in radiation therapy elsewhere in the

body knows that there is a considerable difference in the response of different varieties of tumors and also in many that are histologically similar in type. Pathologists who have studied this phase of malignancy, now recognize different grades of glandular and epidermoid carcinomata (Broders[8-12] and Greenough[13]) based upon tumors. Anyone who has treated many intracranial growths cannot help realizing that this is true. Bailey[14] has taken a very important step in his attempts to separate as many pathological entities as possible among brain tumors and so study the reaction of each one to irradiation.

Bailey[14] has called attention to the lack

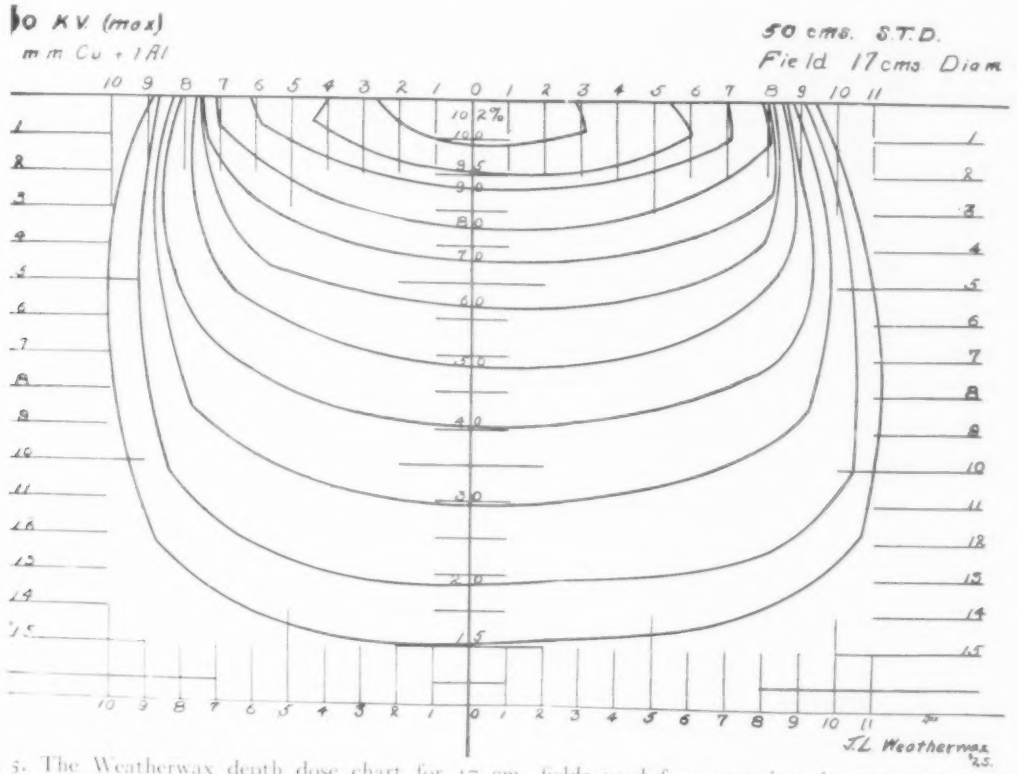
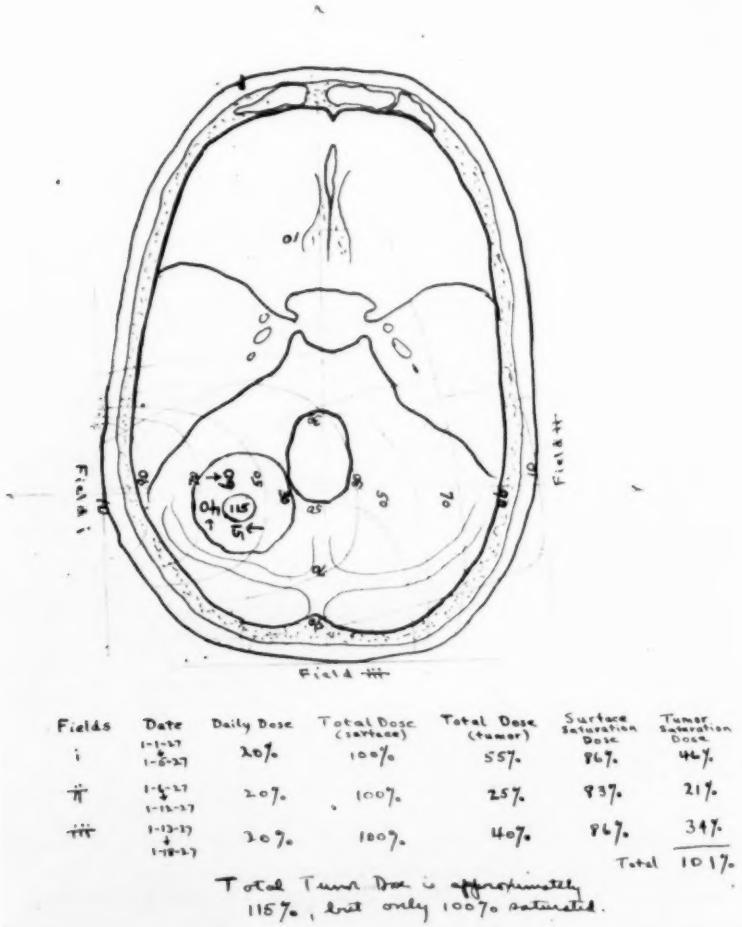


FIG. 5. The Weatherwax depth dose chart for 17 cm. fields used for measuring the approximate dosage through our 8 × 14 cm. ports.

cell characteristics, and from their knowledge of irradiation effects, they are able, in most instances, to prognosticate the effect of treatment. This is true, also, in Hodgkin's disease and other lymph gland tumors. It is a well-known fact that among different tumors, such as the carcinomata and the lymphadenomata, and those of the same type with different cell characteristics, some respond very readily to irradiation, others much less readily, while still others respond very little or not at all. It is reasonable to expect similar variations in different forms of brain tumors and in different histological variations in the same general types of brain

of any favorable response by meningiomata and acoustic neuromata, and has cited cases of gliomata which appeared to be exactly alike in anatomical location, gross appearance and general histological type, but exhibiting diametrically opposite reactions to irradiation. There must, of course, have been some difference in cell characteristics. Our statistics in gliomata which could be compared have shown apparently a very wide variation in response to treatment. We have treated several gliomata of the orbit, and in every instance practically a caustic dose of radium was necessary to destroy the accessible portion of the growth in the orbit, and the tumor has

always recurred, probably from the deeply involved portion of the nerve beyond reach of the caustic dose of radium and unaffected by the external irradiation. Bailey and Cushing[15] have shown that marked histological differences and decided variations in malignancy exist among various members of the glioma group of tumor sites. It is impossible to make any comparisons or to compile any dependable data as long as such widely different methods prevail as at present. (2) Neuropathologists and neurosurgeons must follow along such lines as have been instituted in the admirable work of Bailey and Cushing[15] and others. (3) They must co-operate



Fields	Date	Daily Dose	Total Dose (surface)	Total Dose (tumor)	Surface Saturation Dose	Tumor Saturation Dose
i	1-1-27 ↓ 1-6-27	20%	100%	55%	86%	46%
ii	1-6-27 ↓ 1-13-27	20%	100%	25%	93%	21%
iii	1-13-27 ↓ 1-18-27	20%	100%	40%	86%	34%
					Total	101%

Total Tumor Dose is approximately 115%, but only 100% saturated.

FIG. 6. Diagram showing the possible 100 to 115 per cent depth dose obtainable at a cerebellar tumor site through three 6 × 8 cm. ports as determined by the Weatherwax depth dose charts.

tumors, and they have cited a few examples of quite dissimilar reactions to irradiation.

In order to work out the problem of radiation therapy upon a rational basis, the following three essential lines of investigation are imperative: (1) Radiologists must agree upon a fairly uniform technique which will deliver definite measured doses of deep roentgen rays or gamma rays at with the radiologists in an attempt to group tumors for prognostic purposes, and make it possible for the treatment to be carried out in the most proficient manner.

It is true that we shall have to continue to treat some tumors without operative proof of identity by section, but it is hoped that the number of these will be small. The treatment of brain tumors is compara-

tively new, and as yet more or less crude, and each group has been working along its own lines instead of all meeting on a common ground and comparing notes and becoming proficient for the good of our patients.

SUMMARY AND CONCLUSIONS

1. One hundred and thirty-six intracranial tumors have been treated by irradiation over a period of thirteen years. Of these, 46 were pituitary growths, and are not reported. Of the extrasellar tumors, statistics are available in only the cerebellar group comprising 48 cases. Of these, 25 are known to be alive for varying periods of a few months to thirteen years.

2. The first requisite for adequate treatment is exact operative localization. When the tumor is not localizable, the case can still be treated, but at a distinct disadvantage.

3. Uniformity of irradiation technique is absolutely essential and does not exist at the present time. Much treatment is carried out in a more or less haphazard manner.

4. Radiosensitivity of different types of tumors must be determined before we can reach a decision as to any favorable effects of irradiation or attempt to prognosticate results. This will be possible only through close co-operation among radiologists, neurosurgeons and neuropathologists.

5. Brain tumors must be treated according to the same general principles which apply to tumors elsewhere, but, of course, with due regard to the fact that they are in the brain. A proper combination of external irradiation and radium implantation may be found necessary in many tumors if histological prognostication becomes a possibility.

6. Apparent success ascribed to irradiation may frequently be the result of the operative procedure acting as a decompression.

7. We cannot speak of "cures" in connection with brain tumors with any more justification than in connection with malignant growths elsewhere.

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DISCUSSION

DR. CURTIS F. BURNAM, Baltimore, Md. I have not had the co-operation from the surgical standpoint that Dr. Pancoast has secured, but in 36 cases treated we have had tissue examinations in every case. We have not given the 100 per cent erythema dose except in gliomas.

A recent case turned down by the surgeon even for decompression was treated by the radium pack with splendid results so far. The only case in the series that I feel has been a clinical cure was one of a deep-seated endothelioma, partially removed, which has been well for six years. This patient was irradiated with radium packs for several months and he has been well enough during the past six years to follow his work as a fireman in driving a fire truck, climbing ladders and everything else necessary in his occupation.

We have had no cures in the cerebral gliomas

although some uncured cases have lived a long time. One case has been alive with an extensive tumor for seven years. Our most striking results have been in young individuals with cerebellar tumors, and several with ataxia, inability to walk and with choked discs have returned apparently to normal. We have irradiated these cases on both sides and occasionally from a posterior portal.

DR. H. H. BOWING, Rochester, Minn. Experience in the Mayo Clinic coincides with that of Dr. Pancoast and Dr. Burnam. I have seen some initial effects that have been startling, and I wish I had more data from the neuropathologists regarding the grade of malignancy encountered, for I feel that this would give us an idea as to whether the tumor would be acceptable for irradiation. Very little can be expected from irradiation of the cystic or degenerating tumor. I prefer to have the surgeon remove or drain the cyst when possible and then apply radium. As a postoperative measure irradiation is usually applied after a period of ten days to two weeks, when the wound has healed, as a rule.

DR. GEORGE E. PFAHLER, Philadelphia. I would like to ask Dr. Pancoast whether he has been able to form any opinion whatever in regard to radiosensitivity. It does not seem to me that the saturation method would accomplish more than the other method. It does not seem that these tumors have a greater sensitivity than normal tissue, and we can deliver a sufficient dose by crossfire and save effects upon normal brain tissue to a great extent. This will give much the same effect as radium.

DR. DOUGLAS QUICK, New York City. During the past winter we have rather pooled some cases in New York, with my material at the Memorial Hospital and that of the hospitals where Dr. Lenz works. He reviewed the cases from the histological standpoint and Dr. George H. Hyslop of my service reviewed them from the neurological standpoint. This material was presented before the New York Neurological Society, but has not yet been published. The material was very interesting, but not complete in every detail, but from the cases which could be analyzed, a number of rather suggestive points became apparent. From the radiological standpoint Dr. Lenz made many examinations and estimated the dosage at certain points, assuming that the tumor might be there. We were surprised to find that there was no clear-cut difference in the clinical response between the cystic and infiltrating types of gliomas. There seems to be no prognostic point in the immediate reaction following treatment. The important point was that it was not the total dosage, but the time in which it was administered that counted. Our conclusion was that it must be given within a month or six weeks from the time of starting treatment, rather than in longer periods, and in this I would agree with Dr. Pfahler about pushing the dose in using roentgen irradiation, but I cannot agree with him about not using radium. I do not think it should be used exclusively, but I do think radium can be used quite as effectively as roentgen irradiation, with proper apparatus.

After all is said and done, some help is being given these patients. The fact remains, however, that in comparing them with other groups of neoplastic cases, we are years behind. While we will make some progress, I do not think we will get very far until some capable neurologic surgeon will interest himself sufficiently to take the matter up from our technical standpoint. First, he must sometimes need to have on his instrument table radium in suitable form to use as a surgical instrument, and, secondly, he must convince himself of the value of radium and be willing to limit his operative procedure by using it.

DR. ALBERT SOILAND, Los Angeles, Calif. I would like to refer to one very striking case which came under our observation some years ago. The patient was sent to Dr. Case by Dr. Forssell. Dr. Case discovered a pituitary tumor and treated it for a time, the patient improved and Dr. Case sent him to California. He continued improving for a while and then began to decline. He then came to our office and we made a roentgen-ray examination and found that the tumor was growing. We gave him as much treatment as we dared over a period of a month. I do not remember the exact dose, but he lost his hearing. He did not seem to improve further and we became greatly discouraged. He later returned to his home in Sweden and we did not expect to hear anything more of him, but when in Stockholm last year I asked Dr. Forssell if he had any record of the case, and he said, "Yes, the man is one of our leading bankers and is attending to his business every day."

DR. PANCOAST (closing). Co-operation is an essential factor in treatment, but unfortunately all we usually get is a request from or the consent of the surgeon to treat certain cases. We have not used the saturation dose yet, but we have been gradually feeling our way toward that end. It has been only within the last year or year and a half that we have dared use the large doses which we are now using. We are not afraid to deliver at the tumor site 110 or 115 per cent of a skin dose so far, but this is spread over a period of two or three weeks. I am not opposed to the radium pack and think

we would give it a good trial if we had an opportunity. I have an idea based upon experience of a good many years ago, that radium acts a little more favorably on brain tumors than does the roentgen ray. I think the radium pack can be controlled in its output just as well as roentgen radiation, provided we can get a sufficient dosage at the tumor site. We must be careful to spread this dose over some time, just as with the roentgen rays for if not, we will get into trouble. It is very alarming to have a patient begin to vomit and if not blind, become blind, but with the slower method of treatment this is not likely to occur.

I wish to sound another warning about implantation. Be very careful how this is done and see that it is carried out the way you think it should be done and not the way the surgeon thinks is best. It must be done with the tumor in full view and with the tubes very carefully placed or material damage may result.

The pituitary tumors form a more happy group which we will report later. I have seen a patient with a proven carcinoma of the pituitary body who has been kept alive over a period of five years. I think if we had that patient today with our present method of treatment, we could have done even more for her.

RADIUM IN THE TREATMENT OF LEUCEMIA*

BY WILLIAM L. BROWN, M.D.

CHICAGO, ILLINOIS

LEUCEMIA presents to the physician today a problem which has frustrated all attempts and efforts toward its solution. We know that it is a disease of the blood-forming tissues characterized by a marked increase in the number of white blood cells, many of which are immature, and by splenic and lymph glandular enlargement. The symptomatology, physical findings, course, etc., are quite uniformly known and described in the literature on this subject. The most depressing fact known about the disease is its universally fatal termination. This fact serves as a stimulus to interest in the treatment.

As to the literature relating to this subject, you are referred to the works of Minot, Ordway, Gorham, Vogel and others, who have supplied complete bibliographies covering the field.

The therapeutic agents employed in treating leucemia are primarily symptomatic and palliative measures. Arsenic, iron, etc., are used to combat the anemia and sustain the patient's general condition. Arsenic even in large doses has little or no beneficial effect upon the leucemic picture. Injections of colloidal metals, particularly colloidal gold and sulphur, will reduce the white cell count, but these have not been used therapeutically in leucemia.

It is known that intercurrent infection in the course of leucemia is usually followed by a decrease in the number of white cells. This is particularly true of infections characterized by leucopenia. Gamble, Schupfer and others have injected blood containing malarial organisms into the veins of patients suffering with leucemia, and noted an average decrease of 50 per cent in the number of leucocytes. But a prompt rise to the original high count followed the destruction of the malarial organism with quinine. Unfortunately, the red count and hemoglobin also fell along with the white count and, in most cases, did not improve following the destruction of the malarial organisms. This fact has discouraged further use of this method of treating leucemia.

Benzyl benzoate used incidentally and reported by Haughwout and Asuzano, relieves many of the symptoms common in leucemia, reduces the enlarged lymphatic structures and liver and also lowers the white cell count. But the improvement appears to be temporary only. No ill effects have been known to follow the use of this drug. It is suggested that if used in the earlier stages of the disease and in larger doses it might prove to be of considerable value in the treatment of leucemia.

* Read at the Twelfth Annual Meeting, American Radium Society, Washington, D. C., May 16–17, 1927.

Benzol, used extensively, is of considerable value, yet is dangerous because of possible injuries to the kidneys and liver. Aplastic anemia may follow its injudicious use. Benzol reduces the activity of the leucoblastic marrow, bringing about a reduction in the number of white blood cells. However, there is not a corresponding improvement in the red cell count and hemoglobin. Benzol is beneficial in leucemia if administered properly.

Roentgen rays and radium offer perhaps the most useful and beneficial therapeutic measures we have today. When applied over the lymphoblastic tissues a marked remission in the disease and improvement in the sense of well-being usually follow. The white count is lowered, the red cell count and hemoglobin usually improve, accompanied by a marked reduction in the size of any enlarged lymphatic structures or the liver. No ill effects from the radium treatments have been observed in any cases included in this series.

The above statements relating to treatment apply only to the chronic forms, for, as is generally conceded, no form of treatment influences acute leucemia in any way.

This series covers 22 cases. (1) Myelogenous, 13 cases. Five of these were acute, or in the terminal stages when first seen and diagnosed. All died within two months after the diagnosis was made. Five lived from seven months to three and a half years after diagnosis. One died of typical pneumonia after thirteen months. At the onset of the pneumonia, the blood picture was near normal and had been so for three and a half years after diagnosis and was given radium treatments for three years, five months. One patient has been under treatment two and a half years and is in fairly good condition today. (2) Lymphatic, 6 cases. Three of these were acute or in the terminal stages when first seen, and died in less than three months after diagnosis. One lived fourteen months and died of pneumonia. One patient is living and in fair condition now, three and a half years after onset and three years after diagnosis, during which time she has been under radium treatments. One patient is in excellent condition sixteen months after diagnosis and under radium treatment. The details of the history and findings in this case are given below. (3) Unclassified, 3 cases. These were acute cases, high white cell count, but the blood picture was not characteristic of either the myelogenous or lymphatic type. These patients died within three months after the onset.

Treatment in the acute cases apparently had no effect whatever upon the course of the disease, and the improvement of the blood condition was only slight and transient.

The following case is reported because of the remarkable change in the blood picture and improvement in the patient's general condition following the radium treatments. The blood picture changed from that of a typical high grade lymphatic leucemia to that of normal blood.

REPORT OF CASE

R. H., male, aged fifty, married, 3 children, corporation director, was referred to us January 12, 1926. The patient appeared to be in fairly good general health. He complained of occasional aching pains in various mucles, an uncomfortable feeling in the epigastrium, such as a lump might produce. The latter was not associated with eating, and usually went away spontaneously after a short time. In October, 1925, the patient noted some failure in muscle size and power. Having been a remarkable athlete, he was very sensitive to this muscle change.

During a routine physical examination early in January, 1926, the systolic blood pressure was 155, otherwise the findings were negative, except for leucemic blood picture. The patient was informed of the gravity of his condition and advised to begin radium treatments at once. This information proved to be a severe shock to the patient, who has never been able entirely to rise above the mental depression in which this placed him.

The physical findings were practically negative except for slight enlargement of some of the axillary glands, and a spleen approximately twice the normal size. The reflexes were slightly exaggerated. Blood pressure, diastolic 80; systolic 130. Blood count: red blood cells, 3,860,000; white blood cells, 675,000; Hb., 65 per cent; polynuclear leucocytes, 7 per cent; small mononuclear lymphocytes, 91 per cent; large mononuclear lymphocytes, 2 per cent; numerous ruptured lymphocytes were noted.

Progress and Treatment. The usual sympto-

matic treatment has been necessary and very helpful in this case. Arsenic in various forms has been administered freely. Liq. Auri et Arseni Bromidi, N. F. has been of value at times. Perhaps the most difficult phase, from a symptomatic standpoint, in this case, was the depressed mental state. At times the patient suffered severe fits of mental depression, coming on abruptly and reaching a state almost of insanity with suicidal intent within a very few hours. Occasionally fear of insanity and that he might commit suicide in a moment of mental depression was an obsession of great intensity. These attacks came on more frequently as the patient lost weight and strength and the muscular soreness became more pronounced. After six weeks the patient's general physical and mental condition was such that it was necessary to place him in a hospital with special nurses in constant attendance. He lost weight and strength steadily, even though the blood picture was improving satisfactorily. Sedatives, diet and tonics, were used rather freely during the acute stages of these attacks. Outdoor activities, regular habits and frequent reassurrance of his improvement seemed to lessen the intensity and frequency of these mental attacks. The patient's weight curve is almost parallel with that of his general condition. His weight January 12, 1926 was 177 pounds. There was a gradual decline until May 12, 1926 when he weighed 163 pounds. Since the latter date there has been a steady gain in weight which was back to normal October 6, 1926, and has been around 197 pounds during the past three months.

This patient has been under the constant supervision of internists, dentists and specialists who have attempted to relieve him of all possible sources of infection and to keep him in the best physical condition possible.

Radium Treatment. The applicators in all instances have been placed over the spleen or larger lymphatic groups. Each applicator contained 50 or 75 mg. of radium, screened with 0.8 mm. gold, and 1 inch distance. January 12, 1926, four such applicators were placed over the spleen area for five hours. This was repeated January 27, 1926, and again February 12, 1926. Since that date the patient has had similar treatments at approximately monthly intervals, a total of sixteen applications, five of which were over the enlarged lymph glands in the axillary and inguinal regions.

Regarding the time interval between treatments, it seemed advisable to repeat the application before a marked exacerbation of the condition appeared. It was noted, previously, that patients were inclined to postpone treatments until marked symptoms appeared to convince them of the necessity for further treatment. In some instances this was simply neglect and indifference on the part of the patient, while in other cases it was due to lack of finances. This patient was very eager to co-operate and had treatments as advised. In several cases considered in this report, patients did not return at the appointed time, but waited until their condition was practically hopeless before having further radium treatment. Then with a poor general physical condition and the white blood count increased to 75,000 or 100,000, the radium treatments were of little value. Hence in giving smaller treatments at intervals of approximately one month, it was hoped that the patient's general condition would remain good and the white count low.

Blood Picture Changes. The changes throughout the course of the disease in this patient are shown in Chart 1.

It will be noted that the hemoglobin has increased from 65 to 92 per cent. During the past nine months it has been above 75 per cent and can be considered normal. The number of red blood cells has gradually increased from 3,860,000 to 5,100,000, and has persisted near 4,800,000 since March 8, 1926, two months after the first radium treatment. The total white cell count dropped from 675,000 to 10,200 on March 8, 1926, after the patient had received three radium treatments, a total of 3,250 mg-hr. irradiation. During the past fourteen months an attempt has been made to keep the white count between 8,000 and 14,000. The count March 24, 1927 was reported as 7,000 white cells, 74 per cent polynuclear and 26 per cent mononuclear cells. The differential count has shown the most interesting changes in that on January 7, 1926 only 7 per cent polynuclears were reported, 91 per cent small lymphocytes and 2 per cent large lymphocytes. The percentage of polynuclear cells gradually increased until it reached 64 per cent on July 20, 1926, six months after the first radium treatment. At this time there were 28 per cent small lymphocytes, 4 per cent large lymphocytes, 2 per cent eosinophiles and 2 per cent transitionals. Since this date the differential count has remained well within the limits of normal.

The number of eosinophiles has varied between none and 3 per cent. A like number of transitional cells also has been

Chart 1

Date	Hb.	RBC	WBC	Polynuclears, Per Cent	Small Mononuclears, Per Cent	Large Mononuclears, Per Cent	Trans., Per Cent	Eosin. Per Cent	Baso., Per Cent	Weight, Lb.
1- 7-26	65	3,860,000	650,000	7	91	2				
1- 9-26	65	3,960,000	675,000	8	89	2	1			
1-12-26	Radium	.....	.....	..	..	..	..	..	..	177.5
1-15-26	65	3,720,000	180,000	6	87	5	2			
1-22-26	60	3,900,000	88,000	19	75	4	0	1	1	
1-27-26	Radium	.....	.....	..	..	..	..	..	..	176
2- 1-26	63	4,000,000	31,000	12	73	12	3			
2- 8-26	65	4,300,000	17,000	25	67	7	1			
2-12-26	Radium	.....	.....	..	..	..	..	..	..	173
2-16-26	65	4,300,000	14,800	38	50	10	1	1		
2-23-26	66	4,200,000	13,600	32	46	22				
3- 1-26	66	4,300,000	14,200	44	49	6	..	1		
3- 8-26	70	4,870,000	10,200	51	44	4	1			
3-10-26	Radium	.....	.....	..	..	..	..	..	..	172
3-29-26	73	4,730,000	14,200	53	43	2	2			
4- 2-26	Radium									
4-15-26	65	4,700,000	17,400	62	27	7	1	2	1	
4-16-26	Radium									
5-12-26	Radium	.....	.....	..	..	..	..	..	..	163.5
5-20-26	75	4,900,000	10,600	45	42	10	2	1		
5-26-26	77	5,000,000	10,200	58	36	4	2			
6- 9-26	Radium	.....	.....	..	..	..	..	..	..	163.7
6-10-26	72	4,900,000	10,000	43	49	7	1			
6-21-26	70	4,780,000	13,200	52	38	5	4	1		
6-30-26	70	4,780,000	10,000	59	35	3	2	1		
7-20-26	65	4,730,000	15,200	64	28	4	2	2		
7-26-26	Radium	.....	.....	..	..	..	..	..	..	172
7-30-26	69	4,800,000	11,800	63	25	10	0	2		
8-12-26	85	4,600,000	10,000	62	21	14	1	2		
8-19-26	Radium	.....	.....	..	..	..	..	..	..	173.5
8-25-26	80	4,700,000	11,700	63	31	4	1	..	1	
9- 7-26	80	4,860,000	11,000	50	46	2	2			
9-13-26	Radium	.....	.....	..	..	..	..	..	..	175
9-20-26	75	4,900,000	12,700	62	31	5	1	1		
10- 6-26	Radium	.....	.....	..	..	..	..	..	..	177
10- 8-26	70	4,200,000	12,300	58	27	10	..	5		
10-22-26	Radium	.....	.....	..	..	..	..	..	..	180.5
10-28-26	70	4,900,000	9,100	64	24	8	1	2	1	
11- 3-26	75	4,040,000	8,600	56	34	7	3			
11- 9-26	Radium	.....	.....	..	..	..	..	..	..	183
11-12-26	73	4,600,000	11,000	61	32	2	1	3	1	
11-24-26	78	4,900,000	15,000	73	23	4				
12- 8-26	Radium	.....	.....	..	..	..	..	..	..	187
12- 9-26	80	4,950,000	12,000	70	26	1	1	2		
12-21-26	78	4,760,000	11,300	62	32	2	3	1		
12-30-26	Radium									
1- 3-27	75	4,540,000	10,600	68	29	1	1	..	1	
1-14-27	75	5,000,000	12,000	66	24	8	1	1		
1-26-27	Radium									
1-29-27	77	4,800,000	8,300	60	29	9	1	1		
2- 7-27	86	4,800,000	8,700	62	34	4				
2-18-27	83	5,100,000	9,200	61	33	4	1	1		
2-18-27	Radium	.....	.....	..	..	..	..	..	..	194
2-24-27	85	5,100,000	8,600	64	29	4	2	1		
3- 3-27	92	4,900,000	8,250	72	24					
3-16-27	80	4,680,000	10,700	65	24	9	1	1	..	197
3-24-27	88	4,700,000	7,000	73	23	3	..	1	..	197
4- 5-27	75	4,800,000	10,000	68	29	1	..	2	..	197
4- 8-27	Radium									
4-18-27	71	4,900,000	9,300	64	28	5	1	1	1	
4-26-27	80	4,800,000	8,800	70	24	5	..	1		

recorded. No myelocytes have been reported at any time. The number of blood platelets has varied between 240,000 and 275,000.

Hence, during the past 10 months the differential blood picture in this case might be considered as being well within the limits of normal. The patient states that his general health has never been better at any time in his life than it has been during the past year.

SUMMARY

1. Tonics are considered of value in the symptomatic treatment of leucemia.

2. Frequent blood examinations are necessary, affording an index to the indication for radium treatment and dosage. Frequent radium treatments are considered of value in keeping the blood picture near normal.

3. Poor results are often due to the fact that the patient goes too long without treatment, and extreme exaggeration of symptoms and blood changes develop which are but little influenced by radium applications or any other form of treatment.

4. Constant, thorough medical supervision is necessary to eliminate and prevent intercurrent infections and diseases.

DISCUSSION

Dr. H. H. Bowing, Rochester, Minn. Dr. Brown pointed out that symptomatic improvement or palliation is all that we can expect, and that with satisfactory remission the blood count will be from 8,000 to 14,000. In the Mayo Clinic we have considered even 20,000 a satisfactory blood count. Even though the splenic enlargement may be sufficient to warrant treatment, we prefer to omit it when the blood count is 20,000. Some radiologists advocate a single dose treatment. I prefer to give two or three, or perhaps four, at intervals of from five to seven days and at the completion of each treatment examine the blood. If the number of white cells has decreased and the number of red cells has increased, treatment is continued until a total of 3,000 or 3,600 mg-hr. has been delivered to the superficial glandular and splenic enlargements. In the lymphatic type of leucemia, radium alone is applied to the splenic and superficial enlargements. In the myelogenous type, radium is applied to the splenic enlargement and roentgen rays to the long bones, in the hope of bringing about a more satisfactory remission.

Dr. Robert E. Fricke, Baltimore, Md. I was interested recently in reviewing the cases treated at the Howard A. Kelly Hospital, and found that we have treated 157 leucemias, beginning in the spring of 1915. There were 55 lymphatic and 102 myeloid cases. The youngest patient was two years and four months old, the oldest seventy years, and the average age was forty-eight years and three months. Examining the results of palliation, I consider them very good when I remember the late stage at which the patients come to us. Better palliation was offered the myeloid leucemias. Of those living and under treatment at present, the duration of time from admission is as follows: The shortest case one month, and the longest, seven years and three months. In the lymphatic group, the shortest is six months and the longest, seven years; the average is two years and nine months. Of those who died, the average duration of life from the time of admission in the myeloid group was one and one-half years, and in the lymphatic group, eleven and one-half months. In the myeloid leucemias about 27 or 26 per cent had received treatment by various methods elsewhere before coming to us. In the lymphatic group there were 5 patients, or 9 per cent, treated elsewhere before admission.

Dr. Robert S. Stone, Detroit, Mich. I had hoped that Dr. Stevens, with whom I am associated, would be here to speak of our use of radium chloride intravenously in these cases. As Dr. Brown stated, what we are trying to treat is the systematic or constitutional aspect. We have found that small doses of radium chloride given intravenously produce results at times when we do not wish to apply radium or give deep roentgen-ray therapy. Using the external treatment either by radium or roentgen rays in combination with the intravenous we find the dosage of both for the same result considerably reduced. We have patients who have received this combined treatment and are going along in good condition without further external application of either radium or deep roentgen-ray therapy.

Dr. Brown (closing). We have not used intravenous injections of radium chloride in this particular disease. I think the suggestion regarding its use is well made, and believe it well worth considering. I think it relieves muscular pain in many instances, and that it might be of great assistance in reducing the muscular pain in some of the leucemias.

Regarding the removal of the spleen, I might say that was done in 2 of our cases but we waited until the relatively acute conditions

had subsided and the spleen was practically normal in size. I do not know whether it had much effect one way or the other.

Some of the first doses given to the patient reported were administered in small amounts to satisfy his mental state, and following the blood picture carefully, I noticed that the red blood cells did increase in number, and I thought it well to keep up the treatment regularly. In some instances where I did not keep up the treatments, the patient came back with an exacerbation of the condition. In this particular case, I continued the treatment at approximately monthly intervals and was particularly pleased to see the differential blood count remain so well within normal range.

THE ROENTGENOLOGIC MANIFESTATIONS OF PRIMARY CARCINOMA OF THE LUNG

I. PARENCHYMAL TYPE*

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ROCHESTER, MINNESOTA

IN reviewing the literature dealing with primary tumor of the lung one is impressed with the frequency with which various writers refer to a monograph by Adler in 1912. He gives the most complete account of this subject up to that year, and few new data of value have been added since except on the purely roentgenologic aspect of the subject. Of this Adler made little mention other than to forecast the importance of roentgen rays in the diagnosis. Primary carcinoma of the bronchus as a separate entity has been recognized in only relatively recent years. Adler considers that the first authentic case of carcinoma of the lung was reported by Morgagni in the middle of the eighteenth century, and that cases ofth is disease were recognized clinically and by the gross pathologic manifestations throughout the clinical period of medicine dominated by Laennec in the early nineteenth century. However, it was extremely difficult to distinguish tumor of the lung from gross tuberculous lesions. The ultimate recognition of primary tumor of the lung as an entity really depended on the introduction of the microscope late in the nineteenth century, a period dominated by Rokitanski and, later, by Virchow.

Since the introduction of the bronchoscope and the development of competent bronchoscopy it has been realized that primary malignant lesions of the lung fall into two main groups, parenchymal and bronchial. The pathologic and clinical features of these two types differ considerably, and their roentgenologic appearance allows the same grouping. The bronchial carcinoma is in many ways akin to primary mediastinal conditions and we purpose to discuss the roentgenologic features of this type in a subsequent paper. In this paper we are concerned only with true parenchymal pulmonary carcinoma and we have endeavored to isolate a group of cases at a relatively early stage of the disease in order to discover the characteristic roentgenologic picture. We take as proved cases of early carcinoma those in which a lesion was visible in the roentgenogram, in which palpable nodes in the neck were present and were proved at microscopic examination to be metastatic, and in which there were absolutely no indications of malignant lesions in the abdomen or elsewhere; or, alternatively, cases ultimately coming to necropsy. We have collected 10 of the former and 5 of the latter, all of which have been observed at the Mayo Clinic since 1923. In addition we have studied 12 cases in which the diagnosis was not established microscopically but in which the clinical evidence was well founded.

Pathologic analysis of the cases shwoed

* Read before the Chicago Roentgen Society, Chicago, Illinois, October 13, 1927.

that the majority of the tumors were adenocarcinoma. In 2 cases, however, while the lesions were definitely parenchymal their microscopic appearance was that of epithelioma, the type of malignant lesion most often found in the bronchus.

The clinical course of these cases is extraordinarily latent; pain of an indefinable but persistent nature and loss of weight without apparent cause are the usual symptoms. Later invasion of the pleura, erosion of a bronchus, or infection, produces the usual respiratory triad: cough, dyspnea and pain in the chest. The clinical diagnosis of the cases is, however, anything but simple and far too often they are considered as tuberculous and the patients linger on in sanatoriums unnecessarily. Furthermore, Lilienthal advocates lobectomy as a possible curative measure in these cases if the diagnosis could be made early enough.

The literature on the subject of roentgenology of malignant disease of the lung is more abundant than one would expect for such a relatively rare lesion, and has been produced largely within the last decade. In reviewing the literature we are impressed with the fact that most of the cases were studied late or at necropsy. Therefore the roentgenologic descriptions, as worked out from these cases, represent a more advanced stage of the disease than that represented in our group, and cover both bronchial and parenchymal types. In the literature[4,5,9,11] pulmonary carcinoma as a whole falls into two major groups on the basis of roentgenologic characteristics: (1) hilar or infiltrating, and (2) lobar, nodular, pneumonic or massive.

FIG. 1. Carcinoma of lung, a well-formed apical nodule. Biopsy of a cervical lymph node in this case showed adenocarcinoma, graded 4. The patient was a man, aged fifty-seven. For nine months there had been cough and mild hemoptysis. Four months after the onset of these symptoms there was a feverish illness, lasting for a month, diagnosed pneumonia. Three months after examination the patient died.

FIG. 2. Carcinoma of lung, a small nodular mass above the right hilum. Biopsy from a cervical lymph node showed highly malignant carcinoma. The patient, a woman, aged thirty-four, suffered from pain under the right scapula for six months and had lost 18 pounds. There was temporary improvement from radiotherapy, but death occurred five months after examination.

The hilar tumor is described as an infiltration centered in the hilum, most dense at the hilum and shading into the healthy lung in wide strand-like processes. Assmann showed by contrasting roentgenograms taken immediately before death with the data at necropsy that these processes were probably permeations of the lymphatic channels of the same nature as those which Handley has described in

malignant tumor of the breast. One of the characteristics of the growth at the hilum, observed by Pfahler and others, is its tendency to invade the upper lobe without involving the apex. Only one writer, Tovell, reports greater incidence in the lower than in the upper lobe, and he publishes without case reports. This group of hilar tumors must inevitably include all our cases of bronchial carcinoma.

The lobar or nodular type, called pneumonic by Kerley, has these two main forms. The nodular tumor when seen early consists of a localized area of density, roughly circular, sometimes with satellites peripherally of much smaller size (a point emphasized by Carman) and lacking the sharply demarcated edge of the nodular type of metastatic tumor. The true lobar form fills a whole lobe with a dense homogeneous growth (easily mistaken for caseous tuberculous pneumonia), sharply limited by the interlobar septums. As Barjon has pointed out, if the lesion is not infected, it is confined to the lobe it involves and the rest of the lung is entirely clear whereas massive tuberculosis would seldom be so limited. The lobar tumor is essentially a more advanced growth and is often the later stage of either the nodular or of the roentgenologically hilar, but actually parenchymal, tumor, although never of a clinically bronchial tumor.

To these two groups, Wessler has added another which is rare. In this form there is greatly increased density of the whole ramification of the markings of the bronchial tree but no central mass in the hilum. Wessler suggests that this is a surface type of squamous growth, which spreads superficially along the bronchus and bronchioles but does not erupt through their walls. We have been able to detect 2 cases of this kind, and one was associated with epithelioma of the mouth, and may have been the result of implantation metastasis; the other was apparently primarily parenchymal (Case VIII).

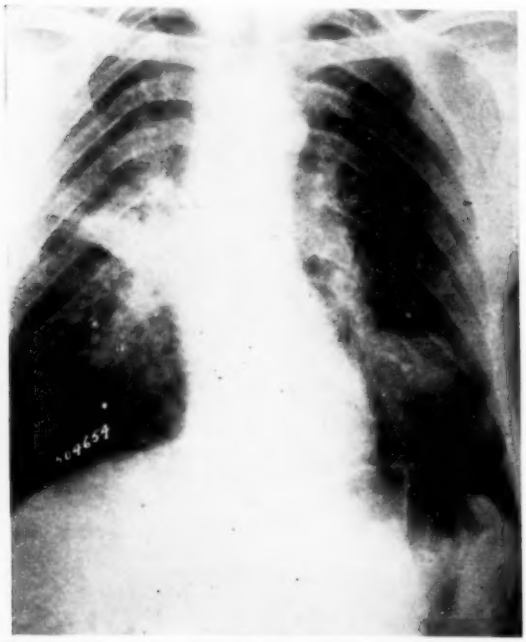

FIG. 3. Primary malignant tumor of the left lung with metastasis to the right lung found at necropsy. The patient was a man aged forty. He did not speak of any symptoms referable to the lungs. He was treated for a pathologic fracture of the spine of unknown cause, and died of postoperative embolus. There was metastasis to the spine.

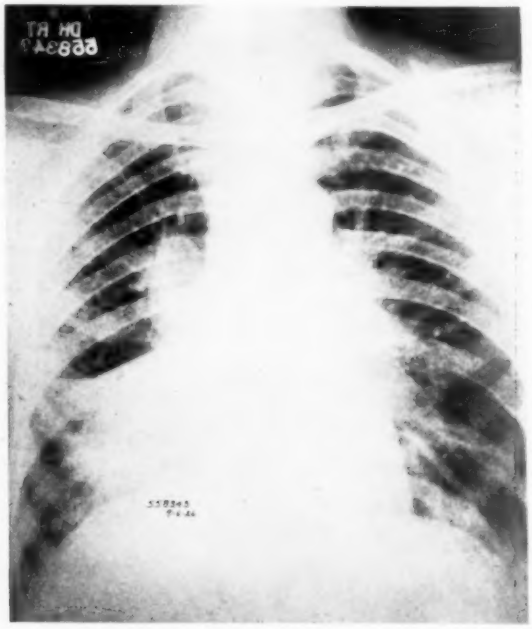

FIG. 4. Carcinosis of the middle lobe of the lung, a lobar type of growth. Biopsy of a cervical lymph node showed epithelioma, graded 4. The patient was a man, aged forty-four. For five months he had had what he called a severe cold, with hoarseness, a feeling of obstruction in the throat and dyspnea. He died a month after examination.

Other types of primary carcinoma of the lung described are: miliary carcinoma or carcinosis (Assmann), multiple nodular carcinoma (Holmes and Carman) and cavernous carcinoma (Kerley). It appears to us that they cannot be justly regarded as types of pulmonary malignant disease: both miliary and multiple types are the results of local metastasis and the cavernous type is merely central necrosis in a tumor of the nodular type.

We are especially interested in this roentgenologic appearance as it is evidence of a stage of development at which lobectomy might be of value if only the diagnosis could be substantiated. The nodule appears as an irregularly circular area of homogeneous density without increase of density at the margin and with edges infiltrating into the healthy parenchyma. It may be found anywhere in the parenchyma of the lung (Figs. 1, 2 and 3). Figure 1 shows

Fig. 5. Primary carcinoma of the upper lobe of the lung with central necrosis and pseudo-abscess. The patient was a man, aged fifty-one. Cough had been present for ten months and recently there had been pain, dyspnea, and loss of weight. The patient died while at the Clinic, and necropsy was performed.

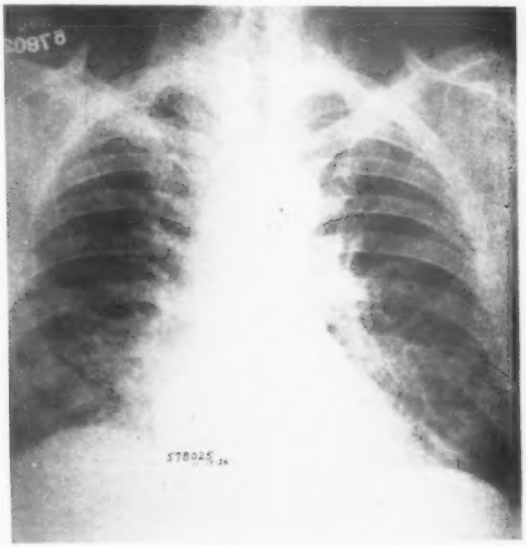

Fig. 6. Carcinoma of lung, infiltrating type. Adenocarcinoma, graded 4, was found on biopsy from a cervical lymph node. The patient was a man, aged forty-nine. For three months there had been cough and the sputum had been tinged with blood; more recently there had been pain in the chest and dyspnea. On bronchoscopy, congestion and moderate stenosis of the right bronchus was visible, but no actual ulceration of the surface epithelium; the growth apparently was extrabronchial.

A cursory study of the roentgenograms in our group of cases leaves one with the feeling that there is an extraordinary variety of possible characteristics and that it is difficult to determine those that might be said to be typical of carcinoma. The earlier cases, however, do fall roughly into three groups: nodular, lobar, and hilar or infiltrating.

The nodular type has been found most commonly in our earlier cases, contrary to other authors' observations, and we believe that all true parenchymal tumors start as definitely circumscribed nodules. a well formed apical nodule, and Figure 2 a much less dense mass just above the hilum. Figure 3 is a roentgenogram from a case in which the diagnosis was proved at necropsy; the mass in the lower lobe on the left was primary, and the infiltration of the hilum on the right was metastatic.

The lobar type is less clear-cut. It appears as a more or less complete consolidation of the whole of a lobe, less dense than fluid, without mottling of any kind, nor with the varied texture seen in most cases of lobar pneumonia, and it has an irregularly infiltrating edge. It may be merely

one stage of growth, as we are inclined to believe, or it may be that there is actually a lobar type in which a carcinomatous process involves practically the whole of one lobe from the beginning, as described by Ewing. Figures 4 and 5 show several forms of the lobar type of growth. Figure 4 probably shows carcinosis of the middle lobe, although it is just possible that this really is lobar atelectasis peripheral to a nodular type of lesion obstructing a bronchus by pressure from without. Figure 5 shows a mass obviously in an advanced stage of growth which was found at necropsy to occupy the whole of the upper lobe.

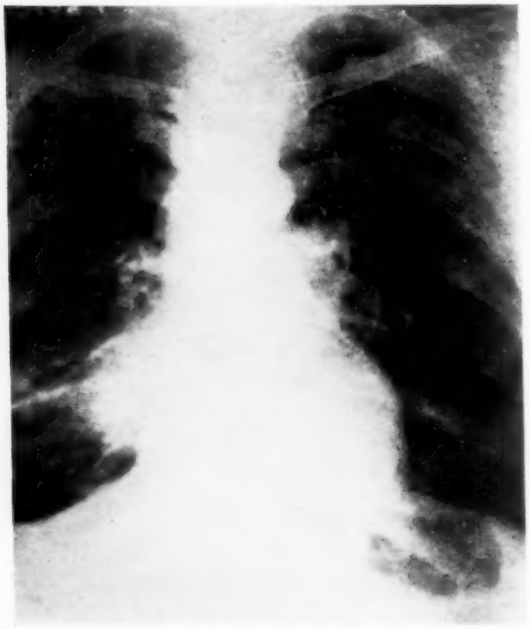

FIG. 7. Partial atelectasis, due to occlusion of a bronchus by pressure from without exerted by an adenocarcinoma of the hilum, found at necropsy. The patient was a man, aged forty-nine. There had been no cough or pain, but for a year dyspnea had increased until it amounted almost to stridor. On bronchoscopy, only bulging of the bronchus could be seen.

The hilar or infiltrating type of lesion is even more difficult to relate to typical roentgenologic characteristics. The infiltrating type, referred to in previous literature, includes most of the cases of bronchial carcinoma. A malignant focus in the lung, but lying near a bronchus in the region of the hilum, may appear in the roentgenogram to be a mass centered at the hilum and infiltrating through the pulmonary tissue toward the periphery. This appearance may be produced either by actual infiltration in a peribronchial form, as in Figure 6, or by partial atelectasis distal to a bronchus occluded from without, as illustrated in Figure 7. It is impossible to distinguish either of these conditions roentgenologically from the appearance produced by a bronchial carcinoma and the diagnosis must be made on bronchoscopic examination.

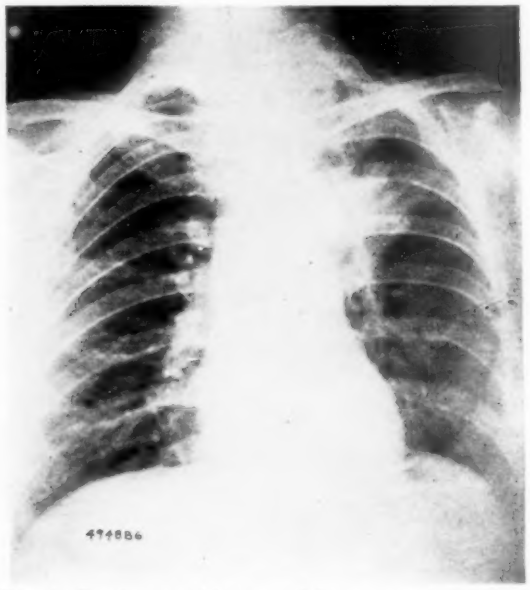

FIG. 8. Carcinoma of lung, nodular type. The patient, a woman, aged fifty-four, had suffered from dull pain deep under the left scapula for eight months. For five months there had been dyspnea, but no cough or other symptoms referable to the chest. She had lost 25 pounds within the five months. Death occurred three months after examination.

These cases illustrate the commoner types of roentgenologic manifestations found in early malignant disease of the lung. As the disease advances secondary processes obscure the picture and it becomes impossible to distinguish by the roentgen ray alone between the primary lesion and the secondary manifestations; the roentgenologist can report only what he sees, that is, the complicating feature.

Fluid is the most important secondary and obscuring condition. In 3 proved cases there were effusions partially or entirely filling the pleural cavity. It would have been necessary to aspirate before any

further roentgenologic diagnosis could have been made.

In certain cases the tumor may grow to involve large portions of the lung, producing a roentgenologic type which one might call "massive." This appearance is often caused by widespread pneumonitis or consolidation surrounding and obscuring the tumor and in such a case no one could do more than suggest underlying malignant disease. Three of our cases were of this nature. In this group we might include a condition noted in one case only (Fig. 5), malignant abscess or necrotic tumor.

Besides the 15 proved cases we reviewed a number of others which were probably carcinoma of the lung but were not proved by biopsy. A study of these cases confirmed our observations, especially as regards the nodular type of which there were 5 more in this group. Figure 8 is another example of the nodular type.

The tabulation on page 26 summarizes certain data in all the cases.

Summarizing, then, we find that malignant tumor of the parenchyma of the lung probably starts as a nodule, homogeneous but not very dense, lying isolated in apparently normal parenchyma, from which it is not sharply demarcated. The nodule grows steadily, infiltrating an anatomic lobe and becoming lobar, infiltrating unevenly and becoming a dense irregular mass, or growing into a bronchus and becoming indistinguishable from typical bronchial carcinoma (a mass of the hilum or atelectasis). Later the pleura becomes affected and fluid obscures the whole picture, or infection supervenes distal to the malignant lesion, with similar confusion of the roentgenologic manifestations.

With this wide variety of possible characteristics the question of differential diagnosis becomes important and we must consider what other lesions take on an apparently similar appearance in the roentgenogram and attempt to note the distinguishing points. In many cases the clinical history and data will make the necessary distinction; however, at present we are concerned only with the roentgenologic diagnostic data.

The isolated round nodule is the most characteristic roentgenologic appearance of early carcinoma of the lung, but there are several other common lesions which appear nodular in the roentgenogram.

Metastasis is the most important; however, a metastatic nodule has not an infiltrating edge, and metastasis is often multiple. The infiltrating form of metastasis is indistinguishable from the infiltrating type of primary carcinoma.

Benign tumors, cysts and hydatids, besides being extremely rare, are distinguished by the sharpness of outline.

Abscess is by far the most confusing condition; indeed, in many roentgenograms the diagnosis can only be that there are two possibilities: malignant disease 50 per cent, abscess 50 per cent. A true abscess, however, usually lacks the homogeneous density of the typical malignant nodule: it either shows increased density toward the periphery of the mass, or it is mottled or found associated with other mottled or patchy lesions. In typical cases a true abscess cavity is too pathognomonic to cause any difficulty in diagnosis except in the rare case of central necrosis in a malignant lesion. Mottling, patchiness, or a lack of centering suggests abscess; homogeneous density and definite centering suggest a malignant lesion. Moreover, abscess often reaches out to involve the periphery of the pulmonary field. This is practically never seen with malignant lesions as fluid obscures the picture by the time the pleura is involved. Involvement of the periphery of the pulmonary field is also the distinguishing feature in cases of encysted fluid or empyema.

Tuberculosis, although the condition most often confused with primary carcinoma of the lung clinically, does not present such difficulty roentgenologically. In tuberculosis there is much the same tendency to mottling, irregularity and multiplicity of lesions as in acute inflammatory processes. Tuberculosis also tends to involve the apex. The lesions in tuberculosis even when atypical can often be distinguished by the absence of any suggestion of roundness: if the tuberculous lesion is circular it is generally a cavity, and the thickened wall can be seen.

Syphilis of the nodular type cannot be distinguished roentgenologically from pri-

mary carcinoma of the lung. Fortunately the condition is rare, and the Wassermann test, followed by observation of the effect of antisyphilitic treatment, must remain the deciding factor.

Pleural plaques and external densities leading to difficulty in diagnosis may be diagnosed by stereoscopic films. These forms do not have the infiltrating edge.

The differential diagnosis of lobar and infiltrating types causes greater difficulty than that of the nodular. Mediastinal conditions are usually obviously mediastinal, but at times they appear very like pulmonary conditions. Here the effect of a course of radiotherapy given as a "therapeutic test" determines the diagnosis.[8]

Inflammatory conditions such as pneumonitis, bronchiectasis or effusions, show some of the characteristics of inflammatory lesions, are less homogeneous than lobar carcinoma, and involve the periphery, in contradistinction to the infiltrating carcinoma which characteristically involves the hilum.

Advanced venous congestion has been mistaken for primary carcinoma of the lung, but the mottling, the multiple foci, the obvious enlargement of the heart, and the history should establish the correct diagnosis.

Atelectasis from bronchostenosis or obstruction by a foreign body has distinctive roentgenologic signs including the way in which the lung texture traverses the area of density, the presence of at least one sharply defined edge, and the associated signs of collapse.

Even with the knowledge gained by experience there is still uncertainty in the diagnosis of primary carcinoma of the lung. Although time is valuable in these cases it is often necessary to repeat the examination after three or four weeks and observe the changes in order to clinch the diagnosis, as malignant growths are steadily progressive. It has been said that in some cases the induction of pneumothorax is invaluable but we have not had experience with this method.

SUMMARY

Previous literature on pulmonary carcinoma has dealt largely with the later stages of the disease, complicated by massive tumor, infection, or the presence of fluid, features which we found also in the late cases studied. The early cases fall into two groups, bronchial (which will be discussed in a subsequent paper), and parenchymal. Parenchymal carcinoma is usually adenocarcinoma and tends to run a rapid, although, at first, a symptomless course.

Three roentgenologic types are described. The nodular type is the most common and consists of an irregularly rounded infiltrating nodule lying completely in the pulmonary fields, usually not involving the periphery. The lobar type is of homogeneous density, occupies an anatomic lobe, and has an infiltrating edge. In the infiltrating type there is increased density of the bronchial tree radiating from the hilum. The differential diagnosis includes a consideration of metastatic tumor, various inflammatory processes, tuberculosis, mediastinal tumor, venous congestion, and other conditions.

ROENTGENOLOGIC DATA IN CASES OF PRIMARY MALIGNANT DISEASE OF THE LUNG

	Cases			
	Diagnosis proved by biopsy	Diagnosis probable	Diagnosis proved at necropsy	Total
Roentgenologic appearance:				
Single nodule	3	4	2	9
Nodule with satellites	..	1	..	1
Lobar distribution	3	3	..	6
Fluid present	2	2	1	5
Irregular mass	1	2	2	5
Miliary (primary lesion not evident)	1	..	..	1
Side involved:				
Right	6	3	2	11
Left	4	9	3	16
Lobe involved:				
Upper	2	9	2	13
Middle	1	1	1	3
Lower	4	1	1	6
Hilar area	2	1	..	3
(Concealed by fluid)	1	..	1	2

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DIVERTICULA OF THE THORACIC ESOPHAGUS

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ESOPHAGEAL diverticula within the thorax have not been frequently diagnosed during life. Such an abnormality at the junction of the pharynx and esophagus long ago ceased to be a pathological curiosity. Sacculations occurring singly below the level of the suprasternal notch have been found at autopsy with somewhat greater frequency than during life, but even as a post-mortem finding they are considerably more infrequent than similar abnormalities in other parts of the alimentary tract. Multiple diverticula have been much more rare. The 5 instances of single diverticula and the 4 multiple diverticula coming under our observation have therefore seemed deserving of a report.

Carman has given an excellent summary of the historical aspect of the diagnosis of this condition. Prior to 1892, such pathology was found only by autopsy. Between this and 1898, some advancement was made and diagnosis effected in a few instances by clinical methods, especially by use of the esophageal probe. Carman credited Reitzenstein (1898) with the first use of the roentgen ray in this condition and stated that 14 cases of deep-seated diverticula were reported between 1892 and 1919, adding one of the epiphrenic type to this list. Two of the 14 were subphrenic. In apparently only one of these (Kelling's case) was the use of the roentgen ray omitted. Carman did not mention Van Swieten, Leffler or Funk, each of whom reported a case. LeCount and numerous others have reported autopsy specimens. The great majority have been found in men.

In the period between 1919 and 1926, inclusive, clinical diagnoses of this abnormality have been found reported as follows:

Author	Portion of Thoracic Esophagus: Upper Third	Middle Third	Lower Third
1. Schmidt	2	2	
2. Armani		1	
3. Hawes		1	
4. Portis			1
5. Dachtler			1
6. Bensaude and Grégoire			2
7. Freud			3
8. Lucas			1
9. Vinson		2	
10. Haenisch			1
11. Dessecker			1
12. Hurst			2
13. Guisez			2
14. Jewett and Lichty	2		1
15. Vogl			1
16. Buckstein	Multiple sacculations in the upper half		

No doubt many other diverticula have been discovered by roentgenologic methods but have never been reported because they were of small size and not producing symptoms. The study of this series has been of some interest from the standpoint of the relative symptoms produced.

The three general types are well established: traction, pulsion and traction-pulsion. Traction diverticula occur most frequently in the mid-portion of the esophagus and commonly result from contraction of the cicatrix of a previously inflamed lymph gland, usually tuberculous. Lahey adds caries of the spine, pleurisy, chalicosis

and mediastinitis as possible causes. Pericarditis has been a factor in some instances. The Zenker diverticulum, at the junction of the pharynx and esophagus, is an example of the pulsion variety. The demonstration, by autopsy, of the absence of adhesions about many of the reported intrathoracic diverticula, particularly of the epiphrenic type, has shown that intraesophageal pressure has been a causative factor. This may result from obstruction below, as by cardiospasm (Dessecker, Vinson), achalasia at cardia (Hurst), or cicatricial stenosis (Flesch, Guisez); from lack of external support, as at the cavum broncho-aorticum (Brosch); from congenital weakness of the esophageal wall (Carman, Dessecker, Vinson); from local bulging from trauma by swallowing large pieces of food (Warthin, Dessecker); or from negative pressure of air in the thorax affecting that in the esophagus (Dessecker). As increased salivary secretion has been a long-standing symptom associated with esophageal diverticula, Jewett and Lichty suggest that this over-supply of saliva, plus advancing age, has been an etiological factor.

Dessecker believes that a history of cardiospasm can always be elicited in these patients, a point not confirmed by the instances herewith presented, but possibly because they were not for the most part symptom-producing. Cardiospasm of even moderate degree would of course tend to herniate mucosa through a congenitally weakened wall. Hurst agrees with Dessecker but prefers to consider this an achalasia, or absence of relaxation, rather than spasm. This functional abnormality was not present in the majority of cases reported in the literature, so that it is probably only one of the etiological factors involved. Carman and Vinson each considered that congenital weakness of the esophageal wall is the most important factor. A consideration of the published case reports and of those personally observed would lead to the conclusion that such congenital weakness is more common than has been supposed and that when trauma, as from a large bolus of food, or cardiospasm is superimposed a herniation may be produced or the size of an already formed traction diverticulum increased.

These sacculations may be only a simple outpouching of all the esophageal coats as in the simplest traction variety, without food retention or the consequent mucous membrane change. These are more likely to be conical (Carman), frequently with the orifice at the lowest portion. In the latter event, the barium suspension will most likely fail to visualize the sacculation unless examination is made in the Trendelenburg position. The orifice may be only a small oval or slit-like opening, parallel to the long axis of the esophagus. In the pulsion type the mucosa and submucosa herniate between the muscle fibers and the sac tends to lie at a lower level with reference to the orifice, so that food retention is more likely to occur, with consequent inflammation and formation of granulation tissue. The right anterior wall of the esophagus is the most frequent site for hernia, especially in the middle and lower thirds.

Warthin speaks of multiple diverticula, but no clinical report of such a type appears to be noted in the literature before that of Buckstein, which appeared after such a diagnosis had been made in 2 of the following cases.

Associated pathology is that of the primarily infected tissue in the case of the traction type, or the secondarily infected structures in any type where retention has occurred for any appreciable period. In the latter, perforation has involved the bronchus (Hawes) or lung (Westergren and Ragnell), with resulting pulmonary gangrene. The association with carcinoma has been surprisingly rare (Carman). Esophageal dilatation secondary to cardiospasm may be present. As will be seen in 2 of the following case reports, herniation of a portion of the stomach through the esophageal orifice of the diaphragm may also be associated.

Symptoms occur only with food retention which is more common in the pulsion type, or some complication such as perforation. In most of the cases reported, symptoms have extended over a considerable period. The disturbances produced depend upon irritation, stenosis of esopha-

gus or pressure upon surrounding tissues. These consist of difficulty in swallowing, regurgitation of food and a feeling of fullness or pain in the lower substernal region, with possibly other symptoms from cardiospasm. There may be true vomiting or pressure symptoms of cardiac pain, palpitation, cough and dyspnea. Apparently diverticula in the lower third are more prone to cause symptoms. Dessecker states that every epiphrenic diverticulum eventually proves fatal. Hurst considers that only those diverticula developing immediately above the diaphragm are of clinical importance, but he had evidently overlooked the report of Schmidt, who found disturbances varying from regurgitation to obstruction produced in 4 patients by single pouches in the upper and middle thirds of the thoracic portion, and also the report of Hawes in whose patient there was perforation from the middle third into a bronchus. Jewett and Lichty also found dysphagia and regurgitation in 2 instances of diverticula in the upper thoracic portion. In this series, only one patient (Case v) with a diverticulum above the lower third suffered symptoms attributable to it. Those in the lower portion appear to be more prone to retain food.

The right anterior erect position is commonly accepted as correct for examination of the esophagus, but it is evident that any slight irregularity of contour on the right anterior wall would not be readily visualized in this manner. Consequently the left anterior position is necessary in almost all of these cases to bring out the proper silhouette. Although in all of the cases described here an intimation of the abnormality was obtained with the patient in the erect posture, it was definitely shown in most of them only by placing the patient in the horizontal or Trendelenburg position with the left chest upward. While in this posture the patient swallows a barium liquid or paste mixture. The esophagus will then remain full for several seconds, permitting roentgenoscopic examination at various angles.

Following are case reports descriptive of symptoms and findings in this condition:

FIG. 1. Case 1. Left anterior oblique view of esophagus and of large herniated portion of stomach. Erect position.

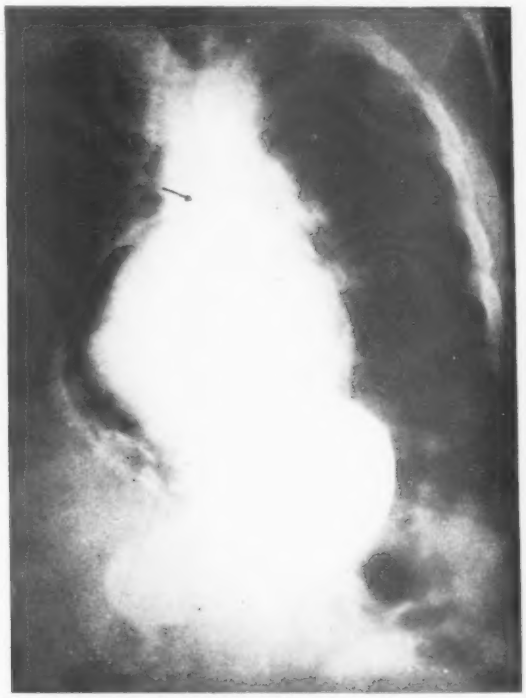

FIG. 2. Case 1. Anteroposterior view of esophagus and stomach, prone position. Arrow marks small residue in diverticulum.

CASE REPORTS

Case 1. *Diverticulum in mid-portion of thoracic esophagus; hernia of stomach through esophageal hiatus in diaphragm.*

Mrs. E. R., aged sixty, referred by Dr. C. R. Rudesill. She complained of constipation, gaseous eructations, general abdominal distress, soreness over lower dorsal vertebrae, and paroxysmal pain beneath the tip of the left scapula. Frequent cardialgia had occurred. During the previous year three attacks of sharp substernal pain had occurred during meals, terminated by vomiting "about a pint of mucus," which gave complete relief.

Roentgen examination on Jan. 24, 1924, showed a diverticulum (Fig. 1) extending anteriorly and to the right behind the upper part of the heart, retaining a small amount of barium during the examination. Below this the esophagus was moderately dilated and extended somewhat to the left to a point near the diaphragm level, then turned to the right at almost a right angle and entered the stomach at a considerable distance below the fundus, without passing through the diaphragm. No appreciable lagging of the barium occurred in the esophagus aside from that in the diverticulum. Fully one-half of the stomach lay above the diaphragm in the posterior chest, chiefly at the right of the midline, extending upward to the level of the esophageal diverticulum (Fig. 2).

Case II. *Irregular sacculations in the middle and lower thirds of the thoracic esophagus.*

E. R., aged fifty-seven, a patient of Dr. C. F. Voyles, entered the Robt. W. Long Hospital for study as to the presence of foci of infection on account of disabling rheumatic pain. There were no gastrointestinal symptoms except constipation.

Fig. 3. Case II. Irregular sacculations in middle and lower thirds of esophagus. Patient in supine Trendelenburg position.

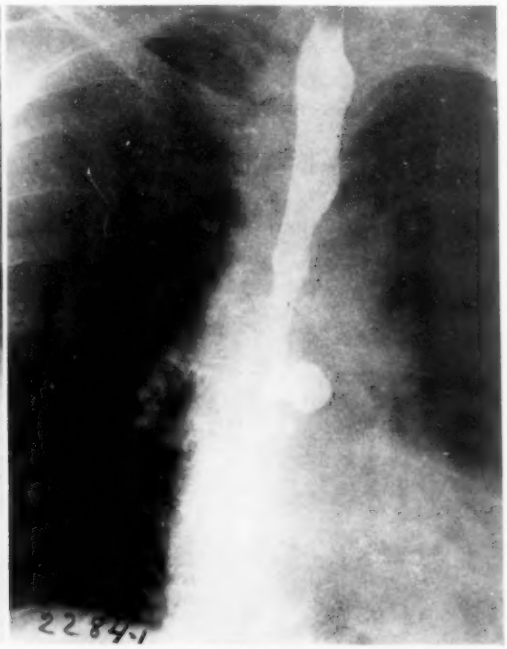

Fig. 4. Case II. Showing unusual appearance of esophagus as it emptied. Patient in supine Trendelenburg position.

Roentgen examination on Aug. 25, 1924, showed a small bulbous projection from the left wall of the esophagus in the mid-thoracic portion, at the level of the space between the sixth and seventh dorsal vertebrae. In addition there were well-defined, multiple sacculations throughout the portion below this (Fig. 3). No retention or delay of the barium paste occurred except that in the supine position it emptied into the stomach more slowly than normally (Fig. 4).

Confirmatory examination for a suspected duodenal diverticulum could not be obtained.

Case III. *Two diverticula in upper thoracic esophagus; slight, irregular sacculations of the middle and lower portions; diverticulosis of sigmoid.*

M. O'D., female, aged sixty-four, entered the Robt. W. Long Hospital as a patient of

Dr. C. P. Emerson on account of a dragging, nauseating distress in midline of upper abdomen, persisting for about five years. This was worse in the early morning, partially relieved by food. Headache and suboccipital pain constantly accompanied the abdominal distress. There were apparently no symptoms related to the esophagus.

Upon roentgen-ray examination, Jan. 2, 1926, there was visualized a small diverticulum projecting upward, anteriorly and to the right in the upper thoracic esophagus. Below this there was a larger and more diffuse sacculation, with only temporary retention of barium here (Fig. 5). Throughout an area of about 6 inches below this there were irregularity and unusual segmentation during deglutition.

Fig. 5. Case III. Irregular sacculations throughout major portion of thoracic esophagus. Left anterior oblique view. Patient in Trendelenburg position.

An inconstant incisura in the stomach, irregularity of the duodenal bulb and absence of a gall-bladder shadow after the Graham test indicated cholecystitis as the cause of gastrointestinal symptoms.

Case IV. *Single, irregular diverticulum in mid-thoracic esophagus.*

M. H. W., male, aged sixty-six, was referred to our office, Jan. 27, 1926, by Dr. E. B. Rinker on account of dyspnea on exertion and the symptoms of angina pectoris. For some months there had also been a sensation that his food was lodging in the lower esophagus, which had caused him considerable distress.

A diverticulum of irregular outline was found in the right anterior wall of the middle third of the thoracic esophagus. This was definitely fixed to some structure at its apex, probably directly to the aorta, as there was a tugging movement at each heart beat (Fig. 6). It retained barium for a minute or two after swallowing. A small dilatation was present above the diaphragm, but it caused no delay of the barium.

Fig. 6. Case IV. Irregular sacculation in mid-portion of thoracic esophagus. Localized epiphrenic dilatation. Patient erect, in left anterior oblique position.

This patient died relatively soon after the examination. No autopsy was obtained, but the clinical symptoms were those of arteriosclerosis.

Case v. *Diverticulum in mid-portion. Less marked sacculations in upper and lower portions.*

A. E. H., male, aged sixty-six, was referred by Drs. C. E. Cox and W. F. Molt to our office, Feb. 23, 1926, on account of difficulty in swallowing during the past month, with regurgitation of food. There had been nausea but no pain. Bile-colored fluid was vomited after eating. He complained also of shortness of breath.

Fig. 7. Case v. Diverticulum in mid-portion. Some sacculation in upper and lower portions. Left anterior oblique view, patient erect.

Roentgenological examination was made by Dr. R. C. Beeler. The thoracic esophagus was irregular in the upper half with a true diverticulum in the right anterior wall of the middle third, an out-pouching about one inch above this and a smaller sacculation just above the diaphragm (Fig. 7). No prolonged diverticular retention occurred. There was occasional regurgitation from the stomach into the esophagus, but the stomach was otherwise negative. There was increase in cardiac and aortic shadows and also evidence of cholecystitis by the Graham test.

Case vi. *Single epiphrenic diverticulum.*

D. S. P., male, aged forty-one, was referred by Dr. A. B. Graham to our office, Jan. 3, 1927, on account of upper abdominal discomfort occurring with stomach empty, only partially relieved by alkalies, present intermittently for ten years. There was no regurgitation, difficulty in swallowing or indication of cardiospasm.

The barium meal filled a small diverticulum about 1.5 cm. in diameter, located just above the diaphragm, anterior and to the right of the esophageal lumen, which retained barium for only a brief interval (Fig. 8). The esophagus was not widened. A deformity of the duodenal bulb indicated a probable ulcer.

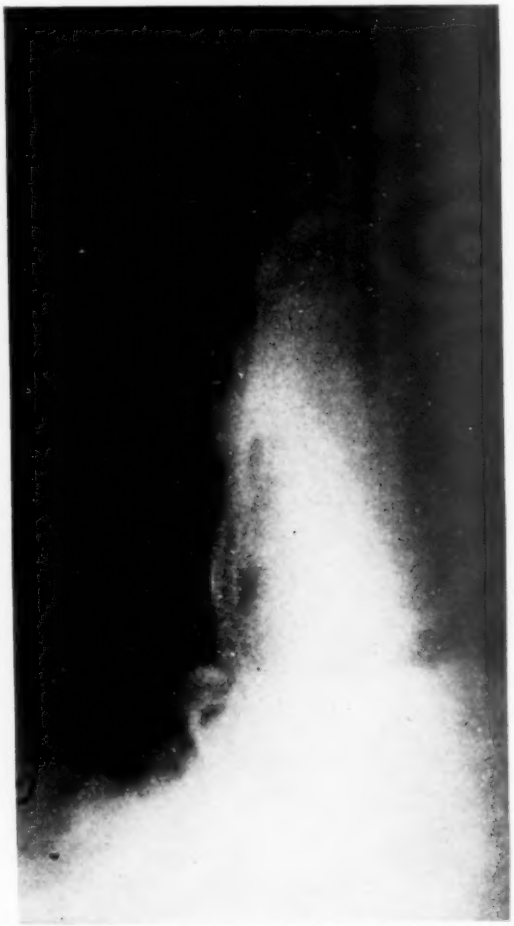

Fig. 8. Case vi. Single, small epiphrenic diverticulum. Left anterior oblique view, patient erect.

Case vii. *Single diverticulum in mid-thoracic esophagus; hernia of stomach through esophageal orifice.*

Mrs. E. C. T., aged sixty-one, was referred Jan. 24, 1927, by Dr. J. A. Craig on account

of a recent severe attack of cramping epigastric pain. This was of the same character as other attacks she had had at irregular intervals for the previous twenty years. The attacks had been immediately preceded by slight diarrhea. The last attack, occurring while patient was at stool, had been so excruciating that her family had thought she was dying.

There had never been any disturbance of

Fig. 9. Case vii. Single diverticulum in mid-thoracic portion, incompletely distended. Patient erect, in left anterior oblique position.

deglutition or digestion other than the symptoms just noted.

A diverticulum 1–1.5 cm. in diameter was present on the right anterior wall of the mid-thoracic esophagus, the pouch being slightly caudad to the orifice, but with no retention (Fig. 9). A small portion of the stomach, including the cardiac orifice, was herniated through the esophageal opening in the diaphragm, displacing the esophagus a little to the right and posteriorly (Fig. 10). No abnormalities were found in the remainder of the gastro-intestinal tract. The patient did not return for the Graham test, as was suggested.

Case viii. *Two diverticula in middle third of thoracic esophagus.*

Mrs. J. E. K., aged forty-nine, a patient of Dr. John Cunningham, complained of a dull aching pain in the right upper quadrant of abdomen of several weeks' duration, not relieved by food or alkalies. She had had flatulent indigestion for several years. There had been no disturbance in swallowing.

Two diverticula, each of about 1 cm. diameter, were found Jan. 27, 1927, on the right

Fig. 10. Case vii. Hernia of cardiac portion of stomach through esophageal opening in diaphragm.

anterior wall of the mid-thoracic esophagus, with no barium retention (Fig. 11). A very irritable colon indicated the probable cause of the patient's symptoms.

Case ix. *Large diverticulum in lower third of thoracic esophagus.*

Mrs. S. B., aged seventy-eight, a patient of Dr. R. H. Moser, was examined by Dr. R. C. Beeler, Feb. 8, 1927, on account of difficulty in swallowing. This dysphagia had been present for ten years, but with occasional remissions. She found it necessary to eat slowly and often in the middle of a meal had to empty much mucus from the esophagus. Liquids and solid foods caused equal difficulty. No abnormal sounds were noted during swallowing. There had been very little loss of weight and no cough. At times there was a sensation of smothering, with shortness of breath and palpitation of the heart. Some edema of the ankles had been noted.

There was a large diverticulum in the lower esophagus, about 3.5 cm. in diameter (Fig. 12). This was about $2\frac{1}{2}$ inches above the diaphragm. The diverticulum had a short, wide pedicle and lay at the right and anterior to the esophagus. There was evidence of food particles here and considerable stagnation of barium occurred. The contents could not be emptied by swallowing water or by change of position. The stomach showed no evidence of pathology.

Fig. 11. Case VIII. Two small diverticula in mid-thoracic portion. Left anterior oblique view.

Clinically this patient gave evidence of arteriosclerosis, cardiac hypertrophy and hypertension.

Of the foregoing instances, Cases II, III, V and VIII are examples of multiple involvement. In Cases VI and IX the location was in the lower third, these being the only ones in this series where the pathology was limited to this portion. There was material esophageal widening in Case I, the only instance where there seemed to be any objective basis for considering cardiospasm. The acute substernal and epigastric pain in Cases I and II, and the lower dorsal and left scapular pain in Case I were of the type commonly associated with temporary obstruction in such diaphragmatic hernias, and cannot be attributed to the esophageal pathology.

The absence of symptoms referable to the diverticula in the majority of these patients is of interest. It is obvious from autopsy reports that roentgen-ray examinations have shown this condition in only

Fig. 12. Case IX. Large diverticulum in the lower esophagus. Left anterior oblique view.

a very small percentage of patients who have it. It would also seem that, since congenital weakness of the esophageal wall cannot be a rare condition, it is because of the relatively low intra-esophageal pressure during deglutition, plus the more or less fluid consistency of the food bolus, that we do not have more frequently in the esophagus a condition analogous to diverticulosis of the colon. It is a common observation that colon diverticulosis is more frequent in the sigmoid and descending portions, where the content is more solid and the intravisceral pressure greater. Cardiospasm, possibly if only transient, would probably materially enlarge these diverticula, especially the pulsion variety, and cause them to produce symptoms. Diaphragmatic hernia is commonly accompanied by cardio-esophageal relaxation rather than cardiospasm (Healy). None of

the cases described gave any history of increased secretion of saliva, mentioned by various writers (Lahey, Jewett and Lichty) as a frequent and early symptom or possibly an etiological factor.

Dessecker found 21 instances of epiphrenic diverticula in the literature. He had evidently overlooked Carman's case. Hurst also reported 2 of this type. Cases VI and IX of this series therefore make 26 reported instances of epiphrenic diverticula.

The hernias described are of interest here primarily because of their association with esophageal diverticula. They are not as infrequent as was formerly supposed. Thoma and Grosse found a total of 238 cases of diaphragmatic hernia reported up to 1900, 8 of these passing through the esophageal orifice. Richards collected from the literature between 1900 and 1923 a total of 137 non-traumatic diaphragmatic hernias, 24 of which passed through the esophageal orifice. Morrison and Healy have diagnosed the condition in 53 instances, many of which however, were included in the tabulation by Richards. In these and the 22 others of the para-esophageal type of which records were found, no mention was made of dilatation of the esophagus. This would indicate that the condition probably does not cause any marked increase in intra-esophageal pressure, and therefore does not tend to produce esophageal diverticula. Possibly the two abnormalities in the same patient merely represent different aspects of congenital weakness. In one of Morrison's patients, there was a para-esophageal hernia, a diverticulum of the upper esophagus and diverticulitis of the colon. In the present series, sigmoid diverticula were present in Case IV.

The symptoms of diaphragmatic hernia and technique of its roentgenological diagnosis will not be discussed here, as these have been thoroughly covered by the writers named. It should be mentioned, however, that in Case I the position of the herniated portion of the stomach in the right chest is unusual. In most cases the stomach enters the posterior mediastinum or the left chest.

We wish to express here our appreciation of the kindness of the physicians referring these patients, in permitting these cases to be reported here.

SUMMARY

1. Nine instances of diverticula of the thoracic esophagus are described, in 3 of which the sacculations were multiple. The latter has rarely been diagnosed during life.

2. This pathology was apparently symptomless in 6 cases.

3. In only 2 of these was the pathology limited to the lower third.

4. These cases appear to indicate that the condition is probably rather frequent but is not diagnosed because not often producing symptoms in the earlier stages.

5. In only one patient was there any evidence whatever of cardiospasm, which has been considered an important causative factor.

6. Congenital weakness of the esophageal wall must often occur and must be considered to be an important factor in production of diverticula.

7. Two additional instances of non-traumatic para-esophageal gastric hernia are described, associated with esophageal diverticula. It may be assumed that these represent different aspects of congenital maldevelopment or structural weakness.*

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*Since submitting the above paper a male patient, aged forty-three, was examined on account of dysphagia, aggravated by coarse food which produced pain severe enough to prevent sleep for some time after it had been swallowed. It had been present for four days, since the onset of a mild acute respiratory infection. It began fourteen years previously and, when present, has always been associated with such an infection.

A small traction diverticulum, with no food retention, was found on the right anterior wall of the mid-portion of the thoracic esophagus at the exact level of the pain.

The symptoms subsided shortly after the examination, as in previous attacks. We believe it can be assumed that localized esophagitis occurs here, secondary to the recurring mediastinal adenitis which originally produced the diverticulum.

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ROENTGENOLOGICAL CONSIDERATION OF THE MEDIASTINUM*

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THE roentgenographic diagnosis of abnormal or disease processes in the mediastinum is baffling and in some instances, at best unsatisfactory.

This may be attributed to a number of different causes, the location of the mediastinum being of greatest importance. It must also be borne in mind that acute inflammation in this region is usually so deep seated that the symptoms do not become apparent for some time. Acute inflammations in the mediastinum are usually secondary involvement to an inflammation of the organs in its vicinity, which overshadow the condition both in regard to the roentgen-ray findings and the symptoms.

The anatomists describe the mediastinum as lying between the right and left pleurae, in and near the median sagittal plane of the chest bounded by the sternum anteriorly and the vertebral column behind, the root of the neck above and the diaphragm below. It contains all the viscera except the lungs and is divided into the *superior mediastinum*, which is that portion above the upper level of the pericardium and the *inferior mediastinum*, that portion below the upper level of the pericardium.

The *inferior mediastinum* is further subdivided into:

(1) The anterior mediastinum, that portion lying in front of the pericardium existing only on the left side.

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(2) The middle mediastinum containing the pericardium and heart.

(3) The posterior mediastinum, that portion behind the pericardium.

From roentgenographic consideration of the mediastinum on the roentgenoscopic screen or the roentgenogram the first point to be noted in the examination, and one of paramount importance, is the position of the trachea. Normally, the shadow of the trachea is seen in the middle of the superior mediastinum. Under normal intrathoracic pressure conditions, the mediastinum maintains its central position. However, it is very sensitive to any change of pressure exerted on either side. Therefore an upset in the balance of the tension exerted on it even though slight, is at once recorded by a deviation to one or the other side. Hence the importance of a variation in the position of the trachea.

Fig. 1. Illustrates the widening of the mediastinal shadow with an irregular lobulated border which was due to a tuberculous mediastinitis.

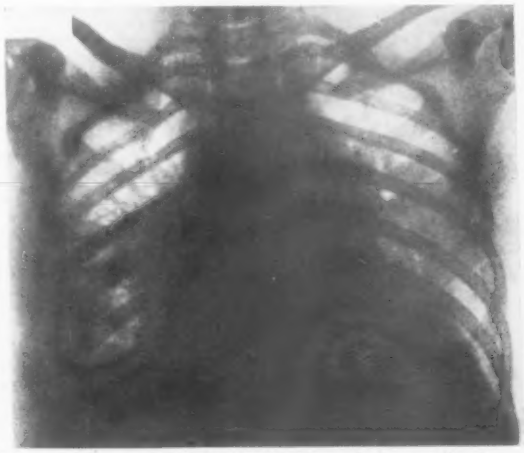

Fig. 2. Shows a marked widening of the mediastinum with fuzzy infiltration in the lungs as a result of mediastinal lymphosarcoma. Autopsy on this patient showed involvement of the mediastinum, thymus and and beginning invasion of the pericardium and erosion of the sternum.

It will not be necessary here to take up the numerous pulmonary and pleural diseases which cause mediastinal changes and the discussion will be limited to conditions involving the mediastinum primarily.

The first condition to be considered is *acute mediastinitis*. As stated previously this inflammation is usually deep seated and a secondary involvement from disease of the lung or pleura.

On the roentgen film a diffuse cellulitis in the mediastinum will produce a generalized widening of the shadow. This is always suggestive and may be an aid in the diagnosis but in itself is not characteristic.

In the diagnosis of mediastinal abscess the roentgenogram may be of the greatest aid. However, the similarity of the roentgen shadow of such a condition is so closely like that of an effusion in the mediastinal pleura that to make a distinction is at best hazardous.

The second point for consideration in this discussion is *chronic mediastinitis*. The commonest cause of chronic inflammations in the mediastinum is glandular and pulmonary tuberculosis. They are most often manifested by irregularities in the cardiac silhouette as a result of adhesions to the pericardium.

At times an actual infiltration occurs causing a widening of the mediastinal shadow. The margin of this widened mediastinal shadow may be sharply demarcated and occasionally it may appear lobulated due to the visualization of the enlarged lymphatic glands.

Chronic tuberculous mediastinitis is usually associated with fibrosis in the upper lobe of one or both lungs. Occasionally in these tuberculous cases the presence of mediastinal bands may give rise to difficulty of deglutition and be sufficiently

severe to require a differential diagnosis between mediastinal adhesions and organic disease of the esophagus.

Such a differentiation is difficult because these bands of adhesions can rarely be detected in the roentgenogram. However, by roentgenoscopy a slight delay in the passage of the barium or a slight deviation in the normal position of the esophagus in the absence of the filling defects of organic disease or the dilatation so characteristic of cardiospasm may lead one to infer that the condition is due to adhesions. Where the evidence of fibrosis in the lung and adjacent pleura is apparent there need be no doubt as to the condition.

The most common cause of chronic

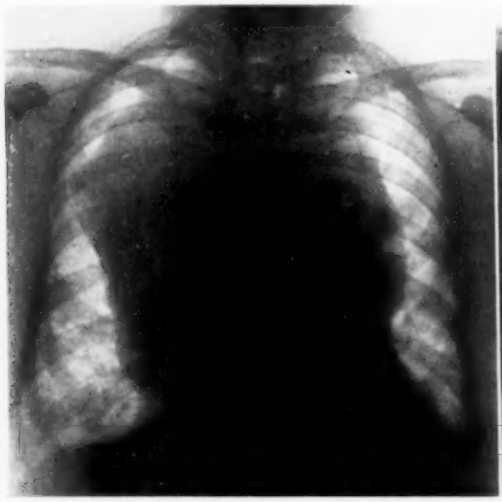

FIG. 3. A massive mediastinal tumor showing bilateral position with the lack of uniformity on the two sides. This tumor was proven to be a primary mediastinal sarcoma.

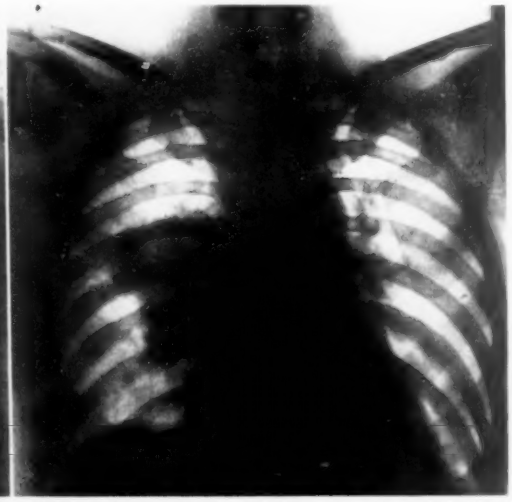

FIG. 4. Note the tumor mass invading the right lung, which arose from the mediastinum and extended into the lung. This tumor was a metastatic carcinoma.

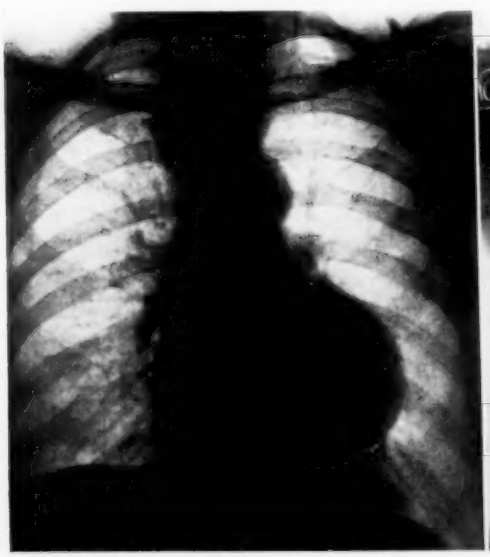

FIG. 5. Shows a large rounded tumor situated posterior to the heart, which was a metastatic carcinoma of the mediastinum. This tumor could not be differentiated by the roentgen ray, but the history was the deciding factor in the diagnosis.

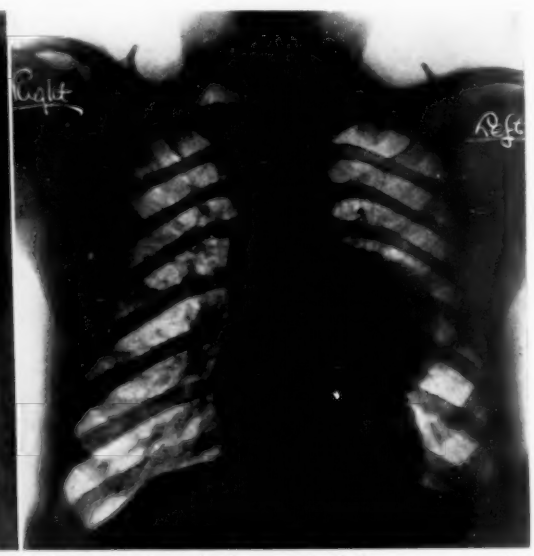

FIG. 6. Note the large rounded tumor extending into the left chest from the mediastinum. This tumor was a metastatic teratoma. Again a differential diagnosis from the roentgen ray alone was impossible.

mediastinitis next to tuberculosis is probably syphilis. Unfortunately, the induration of lues or the gumma is not usually visible on the roentgenograms unless it is of considerable size.

Syphilitic mediastinitis at times produces an unusual picture caused by adhesions between the mediastinum and the diaphragm; this draws the central tendon of the diaphragm obliquely along the border of the heart, obliterating the cardiohepatic angle.

In considering secondary mediastinal tumors, however, the reverse is true, namely, that carcinoma is more common than sarcoma.

The necessity for differential diagnosis rarely arises as the shadows cast by tumors of the mediastinum are so characteristic. However, a note of warning must be sounded and one must pause to consider that aneurysm of the aorta is more often confused with mediastinal tumors than any other condition.

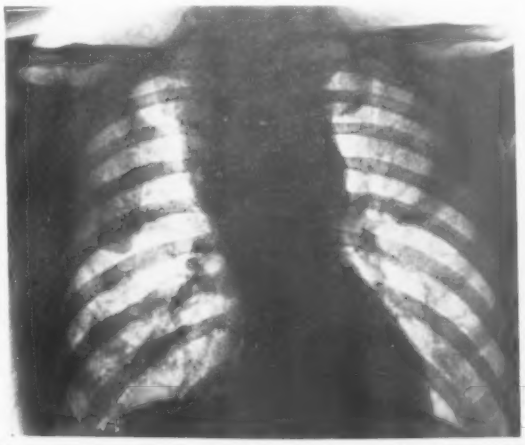

FIG. 7. Large tumor in the superior mediastinum due to a primary mediastinal sarcoma.

Among the rare conditions of chronic mediastinal disease is actinomycosis in which the roentgen shadow simulates a mediastinal tumor. For a differential diagnosis one must depend on the clinical and laboratory findings.

No discussion of the mediastinum is complete without a consideration of mediastinal tumors. The shadows cast by tumors in this location stand out sharply against the surrounding lung and rarely invade it. They are homogeneous and dense. They may be differentiated from primary lung tumor by the fact that they are practically always bilateral. The growth on both sides, however, is unequal in extent. The most common feature of these tumors from the roentgen standpoint is their lobulated border. The differentiation of mediastinal sarcoma from carcinoma cannot be made except by the undoubted rarity of the latter and the occasional demonstration of the typical sarcoma metastasis in the lungs.

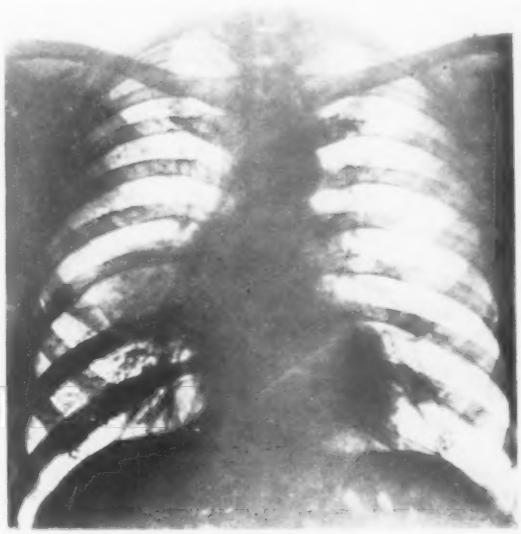

FIG. 8. Rounded smoothly outlined tumor mass which arises in the mediastinum and extends into the right lung. This shadow was cast by a large echinococcus cyst. The cyst ruptured and the diagnosis was confirmed by thoracentesis.

A differential diagnosis between these conditions is often very difficult. The point upon which greatest reliance must be placed is the detection of expansile pulsation and its differentiation from transmitted pulsation, but unfortunately even by most careful roentgenoscopic examination it is at times impossible to differentiate between transmitted and expansile pulsation.

The substernal thyroid and the thymus must be considered. They can usually be differentiated from neoplasm by their location and the character of the shadow cast.

The substernal thyroid is, roughly, triangular in shape. The apex is directed downward and the base or widest portion upward at the root of the neck, merging

with the shadow of the thyroid in the neck. The trachea is also practically always displaced. On the other hand, the thymus though triangular in shape, described by some authors as 'keystone in shape,' has its base directed downward and its apex upward, merging with the shadow of the heart, and fitting down over the base of the heart like a cap. Another differential point for the thymus is that it is encountered most often in young children, and very rarely in adult life.

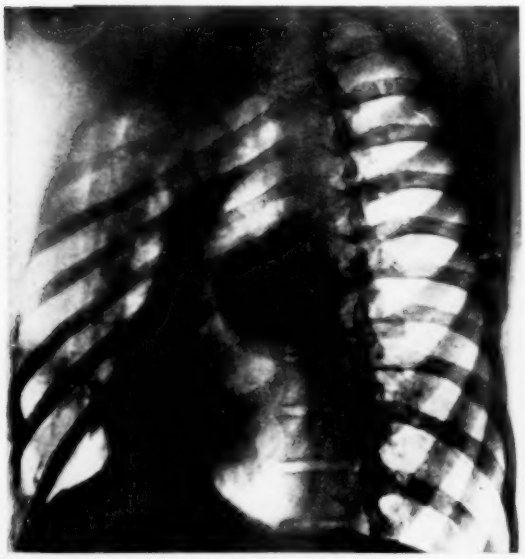

FIG. 9. Same patient as in Figure 8, roentgenographed in the oblique position to demonstrate the position of the echinococcus cyst in the posterior mediastinum.

Dermoid cyst and echinococcus cysts are rare conditions in the mediastinum. Though these cysts cast a definite, and at times a typical shadow, there are many other conditions which are more frequently responsible for this kind of shadow such as massive pulmonary tumor, encapsulated pleural effusion or interlobar collection of fluid. A fairly conclusive clinical history to substantiate the roentgen-ray findings is necessary before a roentgen diagnosis of dermoid cyst can be made, in view of the great rarity of this condition. Two points in the differential diagnosis which are of value are: (1) Dermoid cysts are always located anteriorly. (2) They are usually met with in early life, especially at puberty when they often take on a rapid growth.

Intrathoracic lymph nodes must next be considered. We have adopted the classification given by Wessler and Jaches in the section of their book dealing with this condition. This classification is:

1. Infectious adenopathies.
2. Non-infectious.
   (*a*) Glandular tumors.
   (*b*) Lymphomata.
   (*c*) Hodgkin's disease.

Of the infectious adenopathies the acute type may be dismissed with a few words.

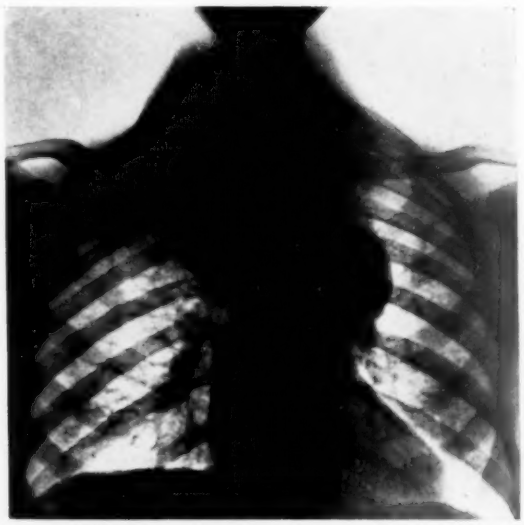

FIG. 10. Large aneurysm of the aorta eroding the sternum and extending upward into the neck. This type of aneurysm causes no difficulty in a differential diagnosis from mediastinal tumor.

The bronchial nodes are undoubtedly enlarged as a result of acute pulmonary and bronchial disease. For example, in pneumonia the hilic shadows are definitely increased in size and similarly after measles and pertussis we note such changes in the hilum.

In children, it is well to bear in mind that the lymphatic system reacts very vigorously to acute infections, simulating in intensity the enlargement of the glands seen in the glandular tuberculosis of infants and may even become so large as to resemble a tumor mass.

The adenopathies resulting from chronic infections are of greater importance. The statement that from the anatomical sense a normal lung root or hilum does not exist may be made without exaggeration. No

individual can escape the irritation and consequent glandular enlargement due to dust inhalation and the various bacterial infections, especially tuberculosis.

The interpretation of these enlarged glands in the hilum has given rise to more confusion than any other condition in the roentgenographic examination of the thorax.

It is questionable, in adults at least, whether such enlarged lymph nodes have any bearing on the clinical picture. It is for this reason that a diagnosis of hilum tuberculosis is not warranted.

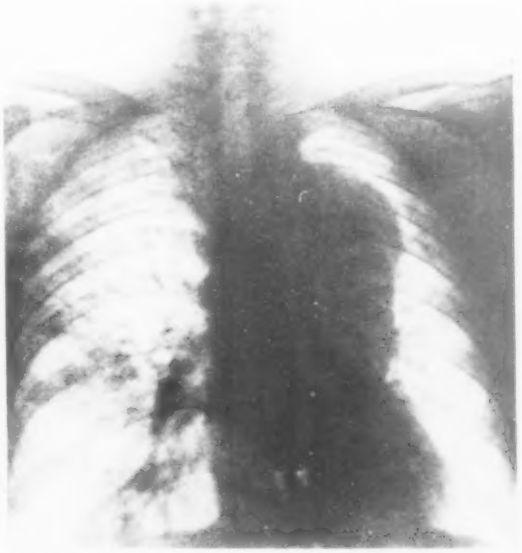

FIG. 11. Illustrates another type of aneurysm of the aorta. This type is exceedingly difficult of differential diagnosis from mediastinal tumor or even lung tumor. It is necessary to depend on the roentgenoscopic examination.

FIG. 12. Illustrates another type of aneurysm of the aorta. This type is exceedingly difficult of differential diagnosis from mediastinal tumor or even lung tumor. It is necessary to depend on the roentgenoscopic examination.

Lymphomata. Lymphatic and myelogeneous leucemia frequently involve the bronchial and mediastinal lymph nodes along with the other glands in the body. The enlargement may take one of two forms. It may be extreme and the individual nodes grow enormously, producing the picture of a true mediastinal tumor or it may cause enlargement of the glands in the region of the pulmonary artery, with which they are easily confused. In the acute leucemias the changes will be similar though more rapid.

Hodgkin's disease presents features which may be considered under four characteristic types: (1) The first of these types appears as circumscribed isolated deposits in the lung. Their shadow is usually quite thin and the linear markings can be seen through them. They may be differentiated from pulmonary metastasis by their lack of perfectly circular outline and the fact that they are frequently grouped in lobulated masses. (2) Among the rare manifestations of Hodgkin's disease from the roentgen standpoint are changes that resemble true mediastinal tumors especially of the lymphosarcoma type. The enlarged glands are situated in the mediastinum but all evidence of the individual nodes is obliterated. (3) Gradation of the type noted in the second class in which the mass or centrally placed lymph nodes extend into the lung and infiltrate the lung extensively. The outline of the growth loses its sharp definition and shades off imperceptibly into the lung tissue. (4) This is the common and typical type of the disease which is the tumefaction of the intrathoracic lymph nodes. They are homogeneous, well defined and the intensity of the shadow is faint. The outline of the individual nodes is often maintained

whereas tuberculosis and anthracosis produce smaller dense irregular shadows.

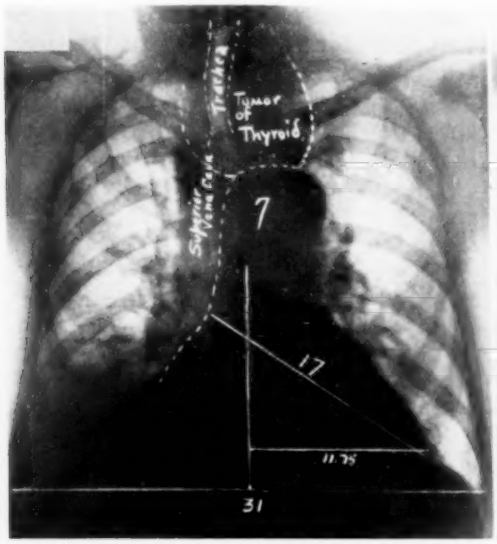

FIG. 13. Illustrates a tumor of the thyroid and marked engorgement of the superior vena cava. The shadows cast on the roentgenogram were duplicated exactly by the findings at autopsy.

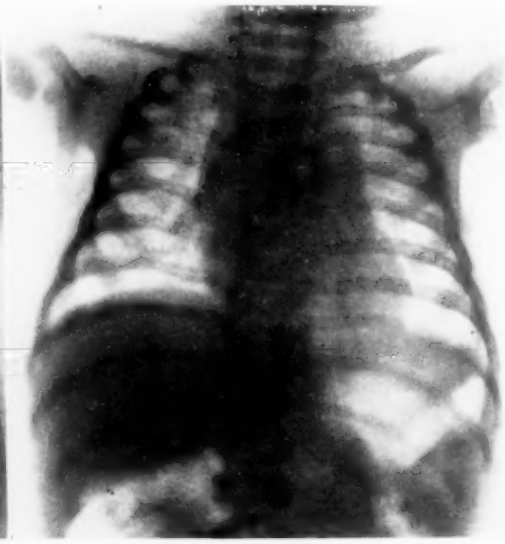

FIG. 14. Shows typical shadow cast by the persistent thymus in an infant. Note the keystone appearance and how the base of the shadow fits over the base of the heart.

Stimulated by the work of Drs. Lambert and Berry of New York, an attempt has been made to repeat their experiments and further to inject opaque material into a body shortly after death attempting to fill the mediastinum before rigor mortis took place and to simulate as near as possible conditions during life. Their effort was to determine whether the spread of mediastinal disease followed definite anatomical paths.

Their conclusions are that the infections travel by definite paths which they divide into five different zones as follows:

(1) Through the broad ligaments of the lungs beneath the visceral pleura and into the substance of the lung down the large branches of the bronchial tree.

(2) Posteriorly along the bodies of the vertebrae to the endothoracic fascia outside of the parietal pleura.

(3) Upward into the fascial planes of the neck.

(4) Downward into the retroperitoneal connective tissue.

(5) Anteriorly beneath the sternum outside the anterior pleural reflections. Exudates in zone one will give rise to roentgen-ray shadows often spoken of as root shadows, and exudates in zone two show large fluid collections which widen the normal mediastinal shadow.

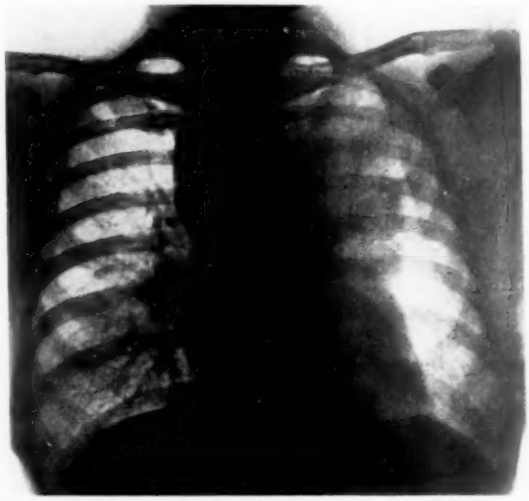

FIG. 15. Illustrates the shadow seen in one type of Hodgkin's disease of the mediastinal glands and shows very beautifully the shading out of the outer margin of the shadow probably caused by the overlying normal lung.

We are unable either to prove or disprove the above statements because unavoidable circumstances have prevented the comple-

tion of our experimentation. As far as our experiments have progressed we have confirmed the findings of Lambert and Berry, but we prefer to wait before making a complete comprehensive report until our knowledge and data are more extensive and our experiments completed.

ABSTRACT OF DISCUSSION

Dr. H. M. Imboden, New York City, stated that the term mediastinitis is rather loosely used in medical literature. Some confine the term to infections of the areolar tissue of the mediastinum, while others use it for almost any thickening or disturbance which may occur in the mediastinum. He had read an article lately in which an ordinary adenopathy was referred to as mediastinitis. He believes the term should be confined to an acute or chronic infection of the mediastinal areolar tissues. He stated that the diagnosis of mediastinitis is not easy and that the widening of the mediastinal shadow in the anteroposterior projection and the blocking out of the shadow in the lateral projection are not always dependable.

Dr. G. W. Holmes, Boston, called attention to two signs obtained under roentgenoscopic observation that he has found of considerable value in the diagnosis of mediastinitis. The first is the movement of the heart with respiration. With the patient in the oblique, or better, in the true lateral view, upon deep inspiration the heart normally moves downward. If there is extensive mediastinitis the heart moves upward. The second is an aid in differentiating intrathoracic goiter. If the patient swallows while under roentgenoscopic observation the shadow moves if it is due to goiter and does not move if it is a mediastinal lesion.

Dr. A. U. Desjardins, Rochester, Minn., discussed the diagnosis of enlarged thymus in infancy. He stated that there is a tendency among roentgenologists to regard the thymus as a standardized structure, while as a matter of fact, it may vary within wide limits in shape, size and position. He cited the case of a ten day old child in whom the roentgenogram showed an enormous tumor on the right side causing great displacement of the heart. There was a clear space above the tumor, complete erosion of one rib and partial erosion of another. He considered the fact that this tumor completely disappeared under very light roentgen therapy as proof that it was an enlarged thymus. Many do not believe that enlarged thymus can erode a rib but, as a matter of fact, it takes very little pressure to interfere with a bone, provided the pressure lasts long enough. In this case as soon as the tumor subsided the ribs regenerated.

Dr. Belden, in closing, said that he agreed with Dr. Imboden that the term mediastinitis, which should be confined to inflammatory conditions, is used too loosely and is often misleading. He stated that he had never seen erosion of the ribs by a thymus but that the thymus is certainly a very changeable organ and varies greatly in size. He emphasized the importance of careful technique in roentgen examination of the thorax for enlarged or persistent thymus. He mentioned a case in which a diagnosis of enlarged thymus had been founded upon a roentgenogram made in the recumbent position and which showed no sign of enlargement when the roentgenogram was made in the erect position.

THE USE OF AMYL NITRITE AS AN ANTISPASMODIC IN THE ROENTGEN EXAMINATION OF THE GASTROINTESTINAL TRACT*

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BOSTON, MASSACHUSETTS

ANTISPASMODICS, particularly atropine, have been widely used and generally accepted as a means of relaxing gastric and duodenal spasm. They are supposed to relax spasm of extrinsic origin and not to relax spasm of intrinsic origin.

All spasm is probably transitory, and if the patient is examined on different days, the degree of deformity will vary and may disappear entirely whether an antispasmodic is given or not, and whether a lesion is present or not. Some superficial ulcers and early carcinomata present very little deformity other than that due to spasm.

If the term spasm is used to describe those deformities occurring in the stomach and duodenum which simulate an organic lesion, and the term pylorospasm to indicate a failure of the pylorus to open in the usual manner, the number of deformities found and attributed to spasm will diminish as our technique and knowledge improve. At the present time we see very few cases in which a deformity of the stomach or duodenum can be attributed wholly to spasm.

When the subsequent history of the patient is considered, a diagnosis of deformity due to spasm has not infrequently to be changed to a diagnosis of deformity due to an organic lesion. In 1914 a case examined showed an annular deformity of the antrum which was not present at a second examination after the use of atropine. One year later this patient had a well-developed carcinoma of the pylorus. A case showing a similar picture was operated upon and the surgeon was unable to make a diagnosis of an organic lesion even with the stomach mucosa exposed. A section from the involved area, however, showed definite evidence of cancer. More recently, a patient with a deformity of the duodenum which was not present at a second examination after atropine, developed symptoms of peritonitis while under medical treatment for duodenal ulcer and at operation a small perforated ulcer of the duodenum was found.

A review of the recent literature, particularly the experimental work in physiology and pharmacology, leaves one in doubt as to the reliability of atropine. It is supposed to relieve spasm by depressing the vagus, yet gastric peristalsis is but little if at all affected by complete vagotomy. It may relax pylorospasm, although when used in the treatment of hyperchlorhydria and pylorospasm the results have been inconstant. A recent textbook on pharmacology states that atropine diminishes the secretion of hydrochloric acid, but has little or no effect on the normal gastric movement. The nerve supply of the stomach is extremely complicated, and it is unlikely that gastric movements can be controlled with constancy by any drug. In undertaking this study we had hoped to present statistical data showing the results obtained with the various antispasmodics when used in cases of spasm both extrinsic and intrinsic, but the inconsistency of results and difficulties in proving the diagnosis have made this impossible and we have had to rely on general observation and the data obtained in selected cases.

As the movements and shape of the barium-filled stomach are constantly changing, it is necessary that observations be made immediately before and at the time the drug becomes effective, otherwise any change in appearance may be due to the time factor and not to the action of the drug. It is obvious that re-examination of the patient after saturation with atropine would be of little value in a study of this kind.

We are indebted to Dr. Joseph C. Aub for the suggestion that the antispasmodic properties of the nitrites might make them

* Read at the Twenty-eighth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Montreal, Canada, Sept. 20–23, 1927.

of value in roentgen examinations of the alimentary canal.

In 1912 experiments were carried out by Hirschfelder, Arnson, et al.,[1] to determine whether the action of nitrites in lead colic might not be due to the relaxation of intestinal spasm. The movements of the intestines were observed by an ingenious device which consisted of a glass window sutured into the abdominal wall of a rabbit. The injection of acetate of lead caused the immediate onset of intense peristaltic movements. These were inhibited by the inhalation of amyl nitrite, by a drop of nitroglycerine on the tongue, or by the injection of sodium nitrite. The effect of the two former drugs was most marked, the effect of the latter more prolonged. Atropine, either locally or intravenously, also inhibited peristalsis. The same phenomena were manifest when peristalsis was brought about by the local application of heat, or by direct faradization of the solar plexus. The results were "uniform, sudden and striking."

The technique of administration is simple. During the course of the usual roentgenoscopic examination, the patient is placed recumbent on the horizontal table, one or two "pearls" are crushed in a wad of gauze, and the fumes inhaled. In a few moments the subject usually complains of a throbbing in the temples, slight dizziness, and a warm flushed feeling. The particular part of the gastrointestinal tract under consideration should be carefully observed at this time, for the effects of amyl nitrite are very transitory. There are no untoward results to be expected. The only precaution necessary is that the patient be prone before the drug is administered. Two of our cases fainted when the fumes were inhaled while standing.

The first patient was a woman of thirty-five who for several months had complained of difficulty in swallowing. She presented definite fullness in the neck, and clinically the possibility of a substernal thyroid was considered. No obstruction to the barium meal was noted, however, until it had reached the extreme lower end of the esophagus. Here it was held up by a definite constriction, and trickled very slowly and intermittently into the stomach. The esophageal outline was smooth throughout, with slight dilatation above the constriction. No amyl nitrite was at hand, and it took some seven or eight minutes to procure it from the pharmacy. During this period the lower third of the esophagus remained filled with the barium. After a few inhalations of the drug, the constriction relaxed and the barium flowed quickly and freely into the stomach. The experiment was repeated on the following day with the same result.

Subsequently, another case of cardiospasm with a fifteen-year history of dysphagia showed no relaxation after amyl nitrite was given. This patient was also given atropine, and calcium intravenously but without change in the deformity.

Three gastric ulcer cases which presented a definite incisura on the greater curvature opposite the lesion showed no relaxation of the spasm after amyl nitrite. Neither was there any change in the deformities resulting from carcinoma of the stomach.

The results in 4 cases of pylorospasm, presumably of extrinsic origin, have been most disappointing. In no case could the sphincter be relaxed by amyl nitrite, although a brief and complete cessation of peristalsis was always observed. Indeed, this effect on peristaltic movements appears to be the most striking action of the drug on the alimentary canal.

Eight cases presenting deformities typical of duodenal ulcer remained unchanged.

Deformities of the colon resulting from carcinoma were unaffected. However, it is in the examination of the colon that amyl nitrite is of definite and practical value. We are constantly encountering a type of colon which, although not organically diseased, is very irritable and difficult to fill, and frequently presents areas of spasm which are very confusing. One or two "pearls" of amyl nitrite will almost invariably relax these colons and permit a rapid and normal filling.

We began using amyl nitrite as a routine instead of atropine in our clinic early in 1927. Since then we have employed it in over 100 examinations. There have been no ill effects and the results, while not all that could be desired, have been as good as when atropine was used. Its effect on

spasm is uncertain, but the same can be said of atropine. The discomfort of the patient is decidedly less, and repeated examinations are usually unnecessary.

SUMMARY

1. Animal experimentation has shown that amyl nitrite and atropine are similar in their antispasmodic action on the gastrointestinal tract. The administration of amyl nitrite is simple, and offers an advantage over atropine in making re-examination unnecessary.

2. Spasm produced by intrinsic lesions of the alimentary tract is apparently unaltered. In this respect the action of amyl nitrite coincides with that usually attributed to atropine.

3. The failure to relax pylorospasm has been disappointing. We are of the opinion that atropine is also of little value in these cases since we are unable to test its immediate effect, and subsequent examination without the administration of antispasmodics of any kind frequently shows a complete disappearance of the spasm.

4. In practically all cases there has been a cessation of peristalsis following the use of amyl nitrite.

5. We have found amyl nitrite useful in the examination of the irritable spastic type of colon.

6. We believe that all antispasmodics are unreliable in their effect upon the stomach and duodenum, and that their value in diagnosis has been over-estimated.

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ABSTRACT OF DISCUSSION

Dr. A. B. Moore, Rochester, Minnesota, stated his belief that spasm of the stomach and of the duodenum due to extrinsic causes is relatively rare. He believes that fright and other mental conditions are very important elements in producing spasm in the gastrointestinal tract, and that it is quite possible that the relaxation of spasm after the administration of belladonna may not be due to the action of the drug so much as to the fact that the patient is not frightened at the second examination. He had never been able to bring about relaxation of spasm by the administration of antispasmodics in cardiospasm.

Dr. Percy Brown and Dr. John L. Kantor of New York also emphasized the effect of fright and other mental conditions, including anger, upon the gastrointestinal tract.

Dr. Holmes (closing). My object in presenting this paper was twofold: First, I wanted to call attention to the use of a new antispasmodic, and second I wanted to call attention to the fact that antispasmodics are not as reliable as is generally believed. That is, if you have a patient with a spasm and you give that patient atropine and the spasm does not disappear, it is rather generally accepted that there is a lesion of the stomach, and if it does disappear, it is almost certain that the patient has no lesion of the stomach. I think we should not accept that as a diagnostic criterion. However, I do not want to go on record as being against repeated examinations. The more we know about gastrointestinal examinations, the more we want to repeat, but it isn't necessary to repeat if everything appears to be normal; where conditions are not normal, we do repeat.

In the original experimental work, nitro-

glycerine was used and also sodium nitrite. We have used nitroglycerine but not sodium nitrite.

With regard to Dr. Kantor's question, the effect of amyl nitrite is, of course, very fleeting, but you have the patient under observation while the effect is taking place and instead of being a disadvantage, that is an advantage. You see it disappear in a few seconds. We selected amyl nitrite because we do not need to fear using it in any patient. The only thing we have to guard against is fainting, and that can be done if the examination is made with the patient prone.

THE STANDARDIZATION OF THE ROENTGEN-RAY DOSE*

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I. INTRODUCTION

THE standardization of a practical unit of dosage of roentgen rays has progressed rather slowly in this country in spite of the painstaking pioneer work of Duane and of many others. The "electrostatic unit" defined by Duane has been in use for many years and is considered by research workers and by a few radiologists to be a satisfactory unit of dosage. Unfortunately this unit has not gained proper recognition from the official societies of the United States. In France and Germany similar units have been officially adopted and are used by most of the radiologists in those countries; while the radiologists of Sweden, Switzerland, and Russia have adopted the official unit of either Germany or France.

II. CALCULATION OF THE ROENTGEN DOSE

Without doubt there are many reasons why the American radiologists should accept and make the best possible practical use of the fundamental data regarding roentgen-ray dosage which have been offered and adopted by the physicists. Nevertheless because of its apparent simplicity many radiologists still advocate and make use of a procedure which depends only upon mechanical factors; yet, as we shall show presently, this method may easily lead to dosage errors of 100 per cent or more. In this procedure the attempt is made to transfer from one therapy apparatus to another such mechanical factors as kilovoltage, milliamperage, distance, filter, etc., with the expectation that when these technical factors are reproduced the radiation output also will always be duplicated. In its simplest form this method is usually based upon a mathematical formula made up of these mechanical factors from which the operator expects to calculate the exact radiation dose. In order to test this method we have calibrated 130 roentgen therapy machines within the past five years (Table 1).

We have found that under identical working conditions, if we depend solely upon mechanical factors, the radiation output actually varies almost 100 per cent when hard filtered rays are used, as in deep therapy, and approximately 150 per cent when light or unfiltered radiation is used, as in superficial and skin therapy. Any mathematical calculation or any mechanical transfer of a certain roentgen dose from one roentgen laboratory to another seems to be practically impossible on account of the variability of the machines and tubes. There is a possibility that with the introduction of the valve tube or kenetron type of apparatus, doses of greater uniformity may be produced, but we hesitate to make such a prediction, since we have examined only six machines constructed on this principle.

It is apparent that it is absolutely necessary that each individual therapy apparatus be accurately calibrated. Continuous calibration of each individual machine by

* Read at the Twenty-eighth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Montreal, Canada, Sept. 20–23, 1927.

TABLE 1

Machine:	From:	Number
Acme International	Acme International X-ray Company, Chicago, Ill.	17
Kelley-Koett	Kelley-Koett Manufacturing Company, Covington, Ky.	33
Standard	Standard X-ray Company, Chicago, Ill.	9
Veifa	Veifa Works, Frankfort, Germany	7
Victor	Victor X-ray Corporation, Chicago, Ill.	8
Waite & Bartlett	Waite & Bartlett Manufacturing Co., Long Island City, N. Y.	14
Wappler	Wappler Electric Co., Long Island	33
Machines of various makes		9
	Total number of machines tested	130

the radiologist is preferable to casual or periodic calibrations, though the latter, of course, are far better than no calibration at all.

III. DOSAGE BY IONIZATION

The radiologist will inquire as to which instrument and which method of calibration are to be preferred. We do not intend to enter into a discussion of methods and theories of dosage since they have so frequently been described in detail. It is a recognized fact that at present the air ionization method is to be preferred to all other procedures and that there are many excellent reasons for this preference. The air ionization method may be used over the whole range of wave lengths employed in radium and roentgen-ray therapy, even down to the oversoft "grenz rays" of about 2 Ångström. Under certain conditions ionization in air runs parallel to many known biological and chemical reactions. The absolute dosage unit based upon this ionization method is the well-known and accepted "electrostatic" or "roentgen unit" or "R unit," and its usefulness has been repeatedly discussed. It is unfortunate that in this country there has never been a recognized standardization laboratory properly equipped to define the standard unit experimentally, to which laboratory the radiologist might send his dosage instrument for calibration in this standard unit; nor is there at present on the American market a dosimeter which is at once practical, easy to handle, and satisfactorily calibrated in "R" units.

IV. EXPERIMENTAL DEFINITION OF THE "R" UNIT BY MEANS OF THE LARGE AIR CHAMBER

In the following paragraphs we shall describe the research which we have undertaken in an effort to overcome some of the existing difficulties associated with the practical measurement of roentgen-ray doses.

In the first place we have re-established the experimental definition of the "electrostatic" or "R" unit by two methods: First, by means of the well-known large air ionization chamber; and second, by means of the "air wall chamber" method of Fricke and Glasser.[1] Details of the construction of the large air chamber have been frequently given but we wish to present our apparatus in order to emphasize a few difficulties and errors which are often encountered, the importance of which has not been sufficiently stressed. Figure 1 is a diagram which shows the construction of our standard system. This air chamber which was designed principally in our laboratory by Hugo Fricke has been described elsewhere.[2] In its present form the outside dimensions of the chamber are $14 \times 22 \times 32$ cm. It is built of sheet brass and is sufficiently protected against stray radiation by lead. The inside of the chamber is painted with a graphite shellac mixture. The measuring electrode E_1 has a surface of 4.983 cm. At a distance of 0.35 mm. from this electrode there are two guard electrodes E_2 with a surface of 11×20 cm. each. (The effective length of the measuring electrode, therefore, is 5.02 cm.) The opposite electrode E_3 has a surface of 26.98×20 cm. The connections to the plates are insulated with amber (for E_1) and bakelite (for E_2 and E_3). The distance between E_1 and E_3 is 10 cm. for all our standard measurements. We shall see later that this distance is sufficient to include all the ions which are created by the radiation which enters the chamber. The chamber is constructed so that the roentgen-ray

beam will pass through it vertically. Only those ions which are formed in the air volume at the center of the chamber are measured. The volume which contains the measured ions is equivalent to that of this frustum of a cone, the dimensions of which are given by the area of the diaphragm D_3, the effective length of the measuring electrode E_1, and the focal distance of the center of the ionization chamber. It is a well-known fact that the number of ions within this volume may be replaced by the number of ions formed in a cylinder the base of which is identical with the diaphragm opening D_3; and its height equal to the length of the effective measuring electrode E_1, the effective focal distance being the same as the focal distance to D_3. The diameter of the diaphragm D_3 is 8 mm.; the effective length of E_1 has already been given as 5.02 cm., and thus the irradiated air volume at the site of the diaphragm is 2.52 c.c. The diaphragm D_3 is mounted on a lead pipe 10 cm. in length, so that secondary rays from the diaphragm edge cannot enter the ionization chamber. A similar pipe is attached at the opposite end where the roentgen-ray beam leaves the ionization chamber. This pipe carries a mirror Sp, which permits accurate sighting of the focal spot through the whole apparatus.

When making measurements with such an air chamber not only must all the radiation from the focal spot enter the chamber, but it is just as essential that this focal radiation should be the only radiation that enters the chamber and that all rays from the stem of the target or from any other parts of the tube or tube holder or any other scattered radiation should be excluded; therefore a system of diaphragms $D_1 - D_2 - D_3 - D_4$ and D_5 must be carefully selected. D_1 is a diaphragm of lead rubber with an opening 1.25 cm. in diameter. This is placed at a distance of only 4 cm. from the roentgen-ray tube. D_2 is a square hole, 1.5×1.5 cm., in the leaded Standard tube shield which surrounds the tube completely. D_3 is the entrance diaphragm of the chamber which is covered with $\frac{1}{100}$ mm. celluloid foil. D_4 and D_5, the diaphragms in the chamber are 2.5 cm. in diameter. We shall see later that all these diaphragms are essential if certain errors in the determination of the standard R unit are to be avoided.

A. Determination of the Volt Sensitivity of the Measuring System.

The measuring electrode E_1 of the air chamber is connected to a gold leaf electroscope M by means of a connection Z, 125 cm. in length. The insulation within this connection is of amber and ceresin which insulates the system perfectly. The chamber and electroscope system are completely

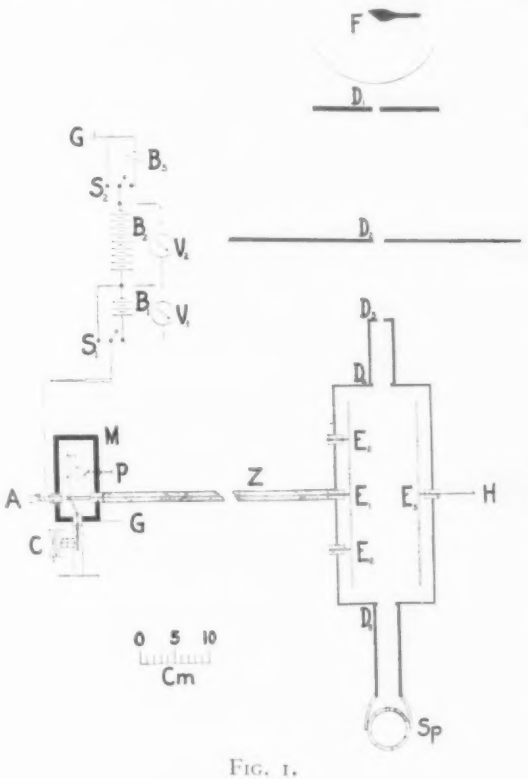

FIG. 1.

enclosed in grounded metal tubes and housings. The sensitivity of the electroscope can be changed by moving the grounded plate P, and in our investigation was usually adjusted so that five divisions of the scale corresponded to 23.5 volts. The electroscope system is charged to minus 180 volts by the B-battery, B_2. Minus 23.5 volts from the battery B_1 can be added to this potential by closing switch S_1. In this way by simply closing this switch (S_1) the sensitivity of the instrument can be constantly controlled for the scale divisions under observation.

In order to facilitate the reading of the first divisions, minus 12 volts from battery B_3 may be added by means of switch S_2 thus charging the instrument still more. A high ohm resistance is connected in series with the batteries and the gold leaf. The leaf can be connected to the batteries by means of a small switch A. A voltage of minus 192 volts is connected to the two guard electrodes E_2; i.e., minus 180 volts plus one-half the potential

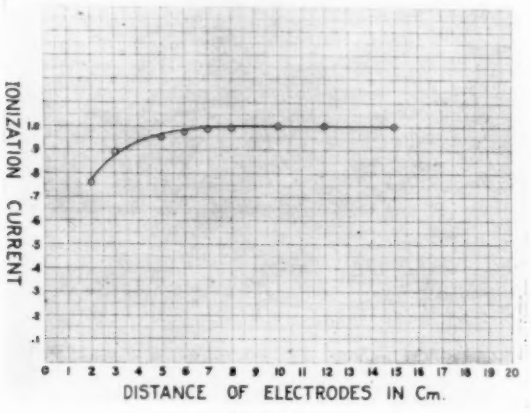

FIG. 2.

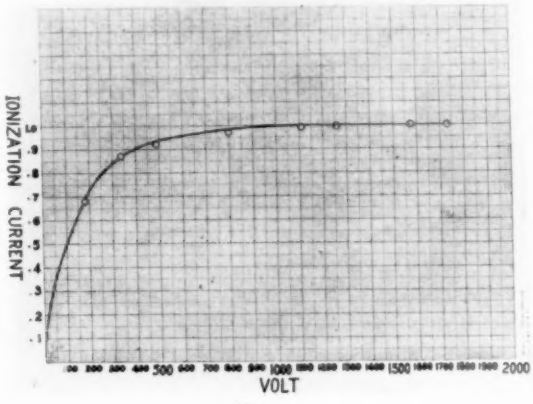

FIG. 3.

over which the discharge of the five divisions takes place. The plate E_3 is charged to a potential of plus 1500 volts, which is furnished by a D.C. generator H. The potential of the test battery B_1 is controlled by a Weston precision voltmeter, model I. The tension of the batteries B_2 and B_3 and that of the D.C. generator are measured by technical voltmeters, Weston model 271.

B. Determination of the Capacity of the Measuring System.

The capacity of the measuring system can be increased by connecting to it the ceresin condenser C. This is important when high radiation intensities are to be measured. The total capacity of the system is observed before each standardization measurement by means of a capacity bridge—type 216 of the General Radio Corporation, with a precision standard condenser—type 222 of the General Radio Corporation. The capacity of our electroscope chamber system is usually 94.3 c.c. without the additional condenser C, and 1320 c.c. when this condenser is added.

Air pressure and temperature readings are made on instruments of sufficient accuracy, and when necessary, corrections for the density of the air are made.

C. Distance between Electrodes in the Air Chamber.

A few important features of such a standard air chamber must be mentioned before we may discuss the accuracy of our determinations of the standard R unit. As we have already stated, the distance between the plates in the chamber must be large enough to include all the ions which are formed by the radiation. To test this we have varied the distance between the plates from 2 to 16 cm. (a procedure which the particular construction of our chamber makes possible). The ionization produced in the chamber for different distances between the plates was measured when using a beam of hard roentgen rays produced at 200 kv. with a 0.75 mm. Cu filter. Figure 2 shows that for these conditions a distance of about 8 cm. or more between the two plates is sufficient to permit all the ions which are formed to be included for measurement. Air chambers with shorter distances than 8 cm. between the electrodes are unsatisfactory for standard measurements if hard rays are used. The distance used in our standardization measurements is usually 10 cm.

D. Saturation Current.

It is well known that with such an arrangement of the ionization apparatus exact data may be obtained only if there

is sufficient potential between the electrodes to produce a saturation current when the measurements are made; in other words, all ions must be measured before they are able to recombine. We have made numerous tests to determine the potential necessary to produce a saturation current in our chamber under different conditions of radiation. The results of a test made as just described with hard roentgen rays and using different potentials at the electrodes, is given in Figure 3. From this curve it may be seen that a saturation current is produced when the potential difference between the plates is about 1100 or more volts. Since in our experiments the potential difference is always 1700 volts the requirements for a saturation current in our air chamber are fulfilled.

E. Diaphragm System of the Air Chamber.

We have previously called special attention to the requirement that all the radiation from the focal spot, and only this radiation must enter the air chamber. To test our diaphragm system in this respect we made pinhole camera pictures of the focal spots directly within our air chamber, replacing the diaphragm D_3 by a pinhole diaphragm the diameter of which was only 0.5 mm. The picture of the focal spot of a Coolidge therapy tube which was obtained in this way is shown in Figure 4*a*, and that of the focal spot of one of our experimental tubes, which was built in our laboratory is shown in Figure 4*d*. In order to illustrate the differences which occur if the precaution of using all the diaphragms is not taken, we first put the pinhole at the site of D_4, i.e., directly at the opening of the chamber which corresponds to the opening of most of the air chambers which are at present in use. With all our other diaphragms in place the picture of the focal spot is shown in Figure 4*a*. If, however, we remove the diaphragm D_1 which is close to the tube, the picture of the focal spot (Fig. 4*b*) shows that a great deal of the stem radiation enters the chamber. If the intermediate diaphragm D_2 is also omitted, still more of the stem radiation enters the chamber, as illustrated in Figure 4*c*. Heretofore these conditions have not generally been taken into consideration in making standard measurements but they are of the greatest practical importance. Using rays of a medium penetration we measured the ionization in the chamber under the different conditions just described and found that the ratio of the radiation intensity for good screening (Fig. 4*d*) as compared with insufficient screening (Fig. 4*b*) with bad screening (Fig. 4*c*) is as 1 to

FIG. 4.

1.09 is to 1.24. Such differences may therefore easily occur even in standard measurements and with each standard instrument careful consideration must be given to proper screening so that errors may be avoided. The screening in our arrangement, as illustrated in Figure 1, is found to be sufficient for standardization purposes. Since the stem radiation is softer than the direct radiation, the ratio just given of course changes with the amount of filtration employed. This point is of sufficient importance to require further study, a report of which will be made in the near future.

F. Calculation and Experimental Accuracy of the R *unit.*

Under given radiation conditions the dose which is effective at the site of the diaphragm D_3 in R units per minute is calculated by the well-known formula (at 18°C. and 760 mm. Hg):

$$\frac{C \times V \times 60}{300 \times \text{vol} \times t} = R/\text{min.}$$

where C is the capacity of the whole measuring system in cm., V the volt-sensitivity of the system in volts, vol the effective air volume in c.c. and t the time of discharge of the electroscope in seconds.

The accuracy with which we are thus able to measure the roentgen unit is better than 3 per cent. The reasons for this

possible error are that the accuracy with which the air volume may be calculated is within about 0.5 per cent; that the determination of the sensitivity is about 1 per cent; that of the capacity measurement is about 0.5 per cent; and that of other factors such as reading of the scale, fluctuation of voltage and current at the roentgen-ray tube may be considered as about 0.5 per cent. The average accuracy of the electrostatic unit as determined in our

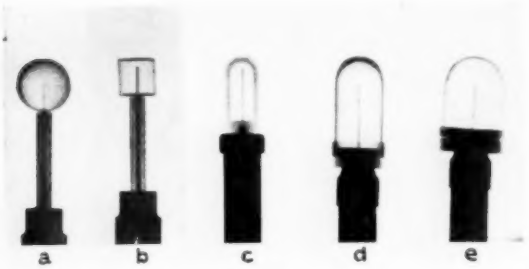

FIG. 5.

standardization laboratory thus lies between 1 and 2 per cent. (This re-established R unit is identical with the electrostatic unit which we have used since 1922. It was first presented to the Central Section of the American Roentgen Society at the meeting in Louisville, February, 1923.)

We believe that, at the present time, if the conditions and precautions above mentioned are observed, the large air chamber is the most suitable apparatus for determining the standard R unit. We feel that the air pressure chamber as advocated by Behnken in Germany offers no advantage over the air chamber which we use and that the Behnken chamber has the disadvantage of introducing added complications without giving greater accuracy.

V. AIR WALL CHAMBER

The other procedure for defining the standard R unit was first presented by Fricke and Glasser[1] in 1925 and was described in detail at that time. By this method instead of the air ionization chamber we use a small ionization chamber with a volume of 1 c.c., the walls of which have an effective atomic number equal to that of atmospheric air, i.e., 7.69. We have demonstrated that this chamber will give the dose directly in R units when the electrical constants, volt sensitivity and capacity, of the measuring apparatus are once established. Originally we used chambers of certain combinations of salts or of a mixture of graphite and magnesium. The former are not rugged enough to be practical, and the latter have not remained constant over a period of four years, this probably being due to oxidation of the magnesium. We now are using successfully a pure graphite chamber with an aluminum electrode. This chamber can be attached by a universal adapter to the end of the electroscope tubing in place of the large air chamber shown in Figure 1. Measurements are made in the same manner as that described above for the large air chamber. Figure 5 shows roentgenograms of the different types of ionization chambers which we use in our laboratory. In Figure 5*a* and *b* are shown our present standard chambers which fulfill the requirements for an ideal standard small chamber (see Kalkbrenner and Küstner,[3] for instance). These chambers are free from any "directional effect" and because of the extremely small area of the amber insulator which carries the electrode the electrical field distribution inside the chamber is almost ideal. Since variation of wave lengths produces no effects, these chambers are suitable for the definition of the standard R unit which they register over the entire range of the wave lengths ordinarily employed in radium and roentgen therapy. There are certain difficulties in the construction of these chambers, since the very purest materials are required and these are most difficult to obtain (see Behnken and Jaeger[4]). We are still continuing our investigations of this type of ionization chamber, since it has distinct advantages over the large air chamber, a fact which has recently been emphasized by Glocker and Kaupp,[5] Behnken and Jaeger,[4] and others.[6]

In Figure 5*c* is shown the ionization chamber of the dosimeter* which we use on the patient during treatment for practical measurements of dosage. This cham-

* Victoreen Instrument Co., Cleveland, Ohio.

ber is made of an organic material, since it must be rugged for practical daily use. It is calibrated in R units by comparison with the large air chamber. For the sake of comparison we show the pictures of two of the best-known small ionization chambers, the original Friedrich horn chamber and the Glocker air wall chamber, which is patterned after the Fricke-Glasser air chamber. Comparative measurements have shown that ionization in our standard chambers of the types shown in Figure 5*a* and *b* is independent of the wave length, if they are equipped with an aluminum electrode. If they have a pure graphite electrode the ionization is of course dependent upon the wave length. Ionization in the Glocker chamber, which Dr. Glocker kindly sent to us a year ago, is not entirely independent of the wave length for very soft rays probably because of the influence of the large amber piece at the end of the chamber. Ionization in the Friedrich horn chamber, given to us by Dr. Friedrich five years ago, shows a considerable variation which is dependent upon the quality of radiation. This variation was pointed out and emphasized by Friedrich and Glasser[7] in 1922.

We may conclude that it is possible to construct an ideal small ionization chamber of certain combinations of material so that it may be used as a standard for the definition of the R unit. Most small chambers in use at present must be calibrated with a large air chamber, and further investigation and simplification is necessary before any of them may be universally accepted as a standard.

VI. COMPARISON OF THE R UNITS OF DIFFERENT LABORATORIES

To return to the standard electrostatic or R unit as it is defined in various laboratories in different countries, it must be stated that up to the present time these units do not entirely agree. We have compared our R unit with the electrostatic units defined by Duane, by Bachem, and by Beets and Arens in their own laboratories (for details see Glasser and Meyer[8]). The units of Duane and Bachem were found to agree with our R unit within ± 4 per cent. This is gratifying, if we take into consideration the numerous physical and mechanical difficulties which attend the determination of these dosage units. The Beets and Arens electrostatic unit shows a considerable difference, and we failed to learn the reason for this discrepancy. It is probable, however, that insufficient screening and the lack of guard plates in the Beets and Arens ionization chamber is responsible for the difference.

Unfortunately it has not been possible to transfer the German Behnken roentgen unit to this country. Though seven calibrated instruments have been examined, the results of the comparison between the American and German R units are still unsatisfactory. The transfer of the French Solomon roentgen unit to this country seems to be more satisfactory, since the French R units of six Solomon iontoquantimeters which we have had occasion to examine show a rather constant relationship to our unit. In order to ascertain the comparative results secured by the different units and instruments, during the last five years we have examined 61 dosimeters based upon ionization. The different types of instruments are shown in Table II. A description of these instruments may be found in the literature. A collective report has been given recently by Küstner.[9]

Each of these instruments was tested very carefully but it would lead us too far afield at this time to explain in detail the results of these tests. Some of the instruments were found to be improperly constructed. Those instruments, the ionization chambers of which are made of materials which have a different effective atomic number than that of atmospheric air, especially those with aluminum chambers, cannot be recommended, for reasons previously stated. The air wall chamber should replace all other chambers, since it has been proven satisfactory for practical purposes. Many of the instruments examined showed considerable leakage due to bad insulation or to insufficient screening against scattered roentgen rays. Only seven of the imported instruments were calibrated in the German Behnken R unit, either in the Physikalisch-Technische Reichsanstalt by Behnken himself,

TABLE II

Instrument:	From:	Number
Bachem Universal Iontoquantimeter	Dr. Bachem, Chicago	3
Dessauer Electroscope	Veifa Works, Frankfurt, Germany	8
Duane Galvanometer	Dr. Duane, Boston	2
Friedrich Iontoquantimeter	Dr. Friedrich, Freiburg, Germany	12
Hammer Dosimeter	C. H. F. Müller, Hamburg, Germany	1
Küstner Eichstandgerät	Dr. Küstner, Göttingen, Germany	1
Martius Ionimeter	C. H. F. Müller, Hamburg, Germany	4
Reiniger Iontoquantimeter	Reiniger, Erlangen, Germany	5
Siemens Dosimeter	Siemens, Berlin	3
Solomon Iontoquantimeter	Ropiquet, Hazard, Paris	6
Standard Iontoquantimeter	Standard X-Ray Co., Chicago	4
Victoreen Dosimeter	Victoreen Instrument Co., Cleveland	4
Wulf Ionometer	Koch and Sterzel, Dresden, Germany	8
	Total number of dosimeters tested	61

or in one of the substations of this government institution. The six imported Solomon iontoquantimeters were calibrated in Solomon's roentgen unit by the manufacturer of the instruments. The seven instruments calibrated in German R units did not agree satisfactorily among themselves,[8] the average deviations being ± 13.5 per cent. As far as can be determined from these average values, there is at present a difference of approximately 50 per cent between the German R unit and our own R unit, the German unit being the larger. Since the average accuracy of Behnken's determination of the unit as well as that of our unit is between 2 and 3 per cent we must conclude that the transfer of the unit from one country to the other has not been satisfactorily accomplished with the instruments at our command.* We are continuing to investigate the discrepancies between the German R unit and our own, and hope that a complete agreement will be reached when Dr. Behnken from the Physikalisch-Technische Reichsanstalt visits our laboratory in the near future. The results of this conference will be reported at a later date.†

As already mentioned, the comparison of the French Solomon roentgen unit as shown by the six instruments gave more consistent results. We found that on the average 2.1 French roentgen units were equivalent to one of our R units. The average variation of the units in the six Solomon iontoquantimeters was ± 5 per cent.

VII. SUGGESTION FOR THE UNIFICATION OF THE DIFFERENT ROENTGEN UNITS

As has been suggested many times, it is very desirable that the French roentgen, the German roentgen, and our own roentgen units should agree and it is hoped that this will be brought about in the very near future. A slight change in the definition of Solomon's unit must be made in order to correlate the French unit with the electrostatic unit. The chamber in Solomon's instrument should be of the air wall type and the distance of the standard radium preparation must be changed. According to the results of our measurements, which we shall report in detail at a later date, the distance of the radium preparation in the Solomon definition of his roentgen unit should be changed from 2 cm. to 1.37 cm. in order to make his unit equivalent to the electrostatic roentgen unit. In other words, the two units are identical if the Solomon definition of his roentgen unit reads as follows: "The absolute unit of the roentgen-ray dose is that intensity of the radiation which produces the same amount of ionization per second as is produced by 1 gram of radium element filtered with 0.5 mm. platinum at a distance of 1.37 cm. from the air wall ionization chamber. The quantity of radiation is found by multiplying the time of application by the radiation intensity expressed in R per second." By making this change in the Solomon definition we would arrive at a definition of the R unit which could be internationally adopted.

* A new test made very recently with another Wulf ionometer was more satisfactory and showed a difference of only about 5 per cent between the two units.

† Since this paper was read the comparison between the German R unit and our own has been made by Dr. Behnken and myself in our laboratory. The discrepancies previously reported were due to faulty construction and lack of proper control of the instruments used in the transportation of the German R unit.

VIII. PRACTICAL INSTRUMENTS, CALIBRATED IN R UNITS

We wish to describe certain instruments calibrated in R units which are of practical value in the measurement of dosage. A dosage instrument which we designed and which promises to be very satisfactory for the busy radiologist was constructed in our laboratory by Mr. V. Seitz of the Electro-Mechanical Engineering Department of the Cleveland Clinic (see Fig. 6). It is

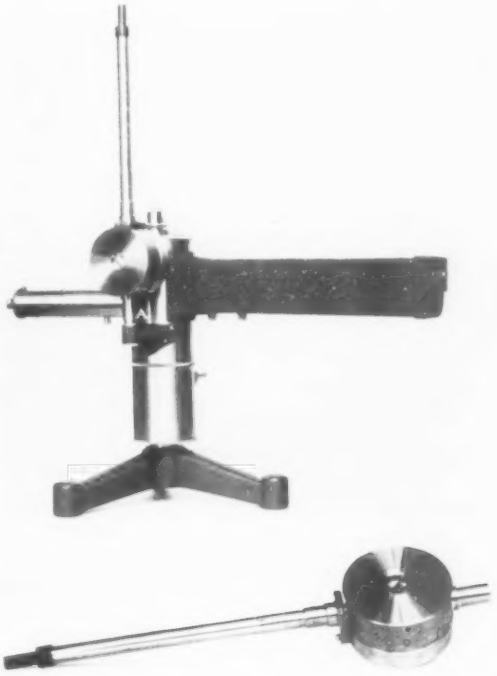

FIG. 6.

somewhat similar to the instruments of Clark[10] and Sievert[11] but has a wider range of usefulness. It consists essentially of two parts: an ionization chamber with a condenser attached, and a string electrometer. The method of using this instrument for dosage measurements is as follows: The condenser and ionization chamber section is connected with the electrometer and the instrument is charged to a known potential. This section is then separated from the electrometer and the ionization chamber is placed in the field of radiation, as for instance on a patient. Thus ionization takes place in the small chamber and under the influence of the radiation the charge of the condenser is partially lost, the amount of the loss depending upon the quantity of radiation. After irradiation for a specified time the ionization chamber section is removed and again connected to the electroscope. The dose applied in the specified time is manifested by the diminution of the electrical charge of the condenser as indicated by the scale of the electrometer. At this time we do not intend to describe in detail the practical uses of this instrument since we have not sufficient experimental data but we desire to mention the instrument because of its simplicity as a practical dosage instrument.

FIG. 7.

An instrument designed from our original dosimeter which we use daily in our therapy department is shown in Figure 7.* It consists of a string electrometer connected by a well-insulated, partly flexible cable with a small ionization chamber which is 1 c.c. in volume (illustrated in Fig. 5c). The electrometer is charged by means of a static charger which is incorporated in the instrument and works very satisfactorily. We measure the dose on each patient and are well satisfied with this safeguard, as well as with the accuracy with which the radiation dosage is determined. The instrument is calibrated in R units by direct comparison with the large air chamber. As discussed previously the ionization in this chamber is almost independent of the wave length, since it is constructed of a special organic material. The discharge time for a given number of divisions on the scale is taken in seconds

*We are indebted to the Victoreen Instrument Company, Cleveland, Ohio, for putting this instrument at our disposal.

TABLE III

Kv.	Ma.	Filter in Mm.	Half-value in Mm. Cu	Average Wave Length	Roentgen/ Min. in Air	Roentgen/ Min. on Patient	Erythema Dose in R Units	Erythema Time in Min.
90	8	.....	0.025	0.60	81	102	.....	.....
90	8	1 Al	0.052	0.46	21	28	500	18
140	8	.....	0.038	0.52	150	185	.....	.....
140	8	4 Al	0.170	0.30	23	36	800	22
200	8	0.5 Cu	0.89	0.16	18	28	1300	47

and divided into the constant obtained by calibration with the air chamber. We thus obtain the number of R units per minute for the radiation in use. For our instrument, for instance, this constant is 740 for hard rays of about 0.15 Ångström. Thus if the discharge time of 30 sec. for any irradiation condition is measured we have at the site of the chamber a dose of 24.7 R/min. If for these same conditions the erythema dose is known to be 1300 units, the time required to reach an erythema dose would be 52½ minutes. The formula is as follows:

$$\frac{740}{\text{Disch T in seconds}} = \text{X (R per min.)};$$

$$\frac{1300\ \text{R}}{\text{X}} = \text{Time for erythema dose in min.}$$

In order to check the working condition of this dosimeter it is calibrated from time to time by a radium standard. A radium standard is placed in the electroscope at a place provided for it. The discharge time of the electroscope is taken and must be invariable for that particular radium standard. Any variation from the normal time usually indicates that some mechanical difficulty has developed. If no mechanical difficulty is found to exist the trouble may be due to atmospheric conditions which have influenced the insulation and conductivity so that for that time the roentgen-ray dosage must be changed accordingly to conform with the variation shown by the radium standard discharge time.

In Table III we have collected a few data from practical measurements made with our therapy machine to illustrate the doses used.

IX. DETERMINATION OF RADIATION QUALITY

At present the radiation quality as measured in our laboratory and treatment room is indicated by the half-value layer of copper in addition to the factors of voltage and filtration. We also transfer these half-value layers into average wave length values in order to make comparisons with data given in the literature. Unquestionably all these terms for the radiation quality are satisfactory only if sufficient filtration is used to make the roentgen-ray beam practically homogeneous (see, for instance, Holthusen and Gollwitzer[12]). None of the absorption measurements are entirely satisfactory for unfiltered inhomogeneous bundles and a total absorption curve should accompany and indicate the quality by half-value layer, effective wave length, average wave length, etc. To avoid the confusion that exists at the present time it would be of great advantage if the radiologists would agree on the adoption of some indication of quality.

X. RELATION OF THE BIOLOGICAL TO THE PHYSICAL EFFECTS OF RAYS OF DIFFERENT WAVE LENGTHS

One word must be added here in regard to the clinical and biological effects of rays of different wave lengths. Up to the present time our experience indicates that the findings of Glasser and Meyer[13] and others on the dependence of the skin effect on the radiation quality are correct only when large areas are treated. For small areas of skin, such as were used in the recent experiments of Determann, Jacobi and Holthusen,[14] there is no dependence upon the radiation quality

as we also have emphasized in a former publication.[13] We are now extending our previous investigations to the oversoft "grenz" rays as used by Bucky, and with these rays we find approximately 300 R units per erythema. A comparison of this erythema with those obtained with harder rays is difficult, since no epilation is produced with these very long wave lengths. It has not yet been fully explained why in certain instances a difference in dosage has been found for different wave lengths while in other instances there is no difference. (See, for instance, the investigations of F. C. Wood, Glocker, Fricke, and others.) We are continuing our experiments in this direction and hope to report our results at a later date.

XI. SUMMARY

In conclusion, we may say that we have attempted to re-establish the old electrostatic unit or the roentgen unit as accurately as possible and have made extensive experiments to correlate this unit with those similarly defined by other investigators in this country and abroad. This has been done by comparisons of results secured in several research laboratories or by means of calibrated instruments in our own laboratory. Since this is a very difficult and complicated problem the results of these comparisons are not entirely satisfactory as yet but we intend to continue our efforts so that we may accumulate more scientific data and at the same time assist the profession to arrive at a standard dosage.

Practical dosage instruments based upon ionization have been developed and calibrated in R units. These instruments make it possible to measure doses on the patient in absolute and reproducible units.*

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DISCUSSION

DR. G. FAILLA, New York City. Among radiologists there is a great diversity of opinion as to the import of roentgen-ray standardization. Some think that as soon as we have standard units for dosage purposes all their difficulties will be overcome; while others maintain that standards will be of little value because the clinical factors are so variable. These are extreme views which are not shared by the majority of radiologists, but they emphasize the misunderstandings which are apt to occur.

We may get a more definite idea of the question of standardization under discussion by an analogy. Suppose we had no standard of weight and no simple and reliable scales. In a

* Most of the technical equipment constructed for this research has been built by Mr. V. B. Seitz, Chief of the Electromechanical Engineering Department, and by Mr. I. E. Beasley of our department, and we wish to express our appreciation of their help. Part of the standardization work has been done in collaboration with Dr. Wm. H. Meyer of New York and Dr. Hugo Fricke of Cleveland, and we wish to express to them our appreciation for many valuable suggestions. We wish also to thank the Victoreen Instrument Co., Cleveland, Ohio, who have constructed and presented us with the dosimeter described above.

community, each butcher, for instance, would have scales of a different type, and weights of his own choosing. He could sell meat on this basis, and his customers would soon learn how to order from him. A dissatisfied customer would have to learn another butcher's system of weights and prices before patronizing him. Assuming also that scales were hard to get, and required special training on the part of the user, a housewife could not determine readily where she would get the best value, since she would have no simple way of comparing prices for the same amount (and quality) of meat.

Aside from the usual difficulty of getting people to agree on anything, it would be a simple matter to set up a standard of weight to be used by every merchant in town. It would be only necessary to select a piece of brass (for instance), keep it in a convenient place, and agree that everything sold by weight should be expressed in terms of this unit. Other pieces of brass of equal weight could be distributed to different merchants to be used as secondary standards. In a case of this sort, the size of the unit, the material to be used for the standard weight, etc., would be subject to lengthy discussions, but these factors are relatively irrelevant.

Since we have assumed that in our hypothetical community, scales and balances are not simple and reliable instruments, the full benefits of the adoption of a weight standard cannot be derived until scales possessing the desired requisites are developed. This part of the problem cannot be solved simply by friendly discussions, but requires experimentation. Sooner or later we would have good spring balances, beam balances, steelyards, etc., and we would know the merits and demerits of each. We could then adopt a certain type to make comparisons with our standard, and to calibrate all the others.

Without repeating the above discussion for the case of roentgen rays, it is evident that the definition of a unit of intensity or quantity is a relatively simple matter. The real problem is the development of a suitable measuring instrument which can be used by the radiologist to express roentgen doses in terms of the adopted unit. The problem is rendered very difficult by the fact that the amount of energy available in a roentgen-ray beam is very small, and that therefore very sensitive and delicate instruments must be used for the measurement of roentgen rays. This is an inherent difficulty which will be hard to overcome.

All dosimeters which have been developed so far require on the part of the operator intimate knowledge of their characteristics, the sources of possible error, etc. This knowledge is not possessed by the average radiologist, who cannot be expected to have an extensive training in physics. Furthermore, it is doubtful whether the radiologist who has the necessary training should spend much time on the purely physical side of the work. It seems to me, therefore, that it is safer and more economical to have roentgen-ray measurements made by a physicist.

The necessity for making roentgen-ray measurements in the clinic presents itself in two ways: (1) The radiologist should be able to duplicate or control roentgen-ray doses in his own department at any time; (2) he should be able to compare doses (and results) with those of another clinic. The question of standard units comes in only in the second case. Accordingly the universal adoption and actual use of certain roentgen-ray standard units will not influence *directly* the work of any radiologist in his own clinic. It will, however, make possible the comparison of his work with that of other clinics, which obviously is very desirable.

Now the adoption of the required roentgen-ray units is relatively simple; but expressing doses in these units is not, because of the difficulties of roentgen-ray measurements mentioned above. Accordingly this is the real problem. The work reported by Drs. Glasser and Portmann is very important in this connection. They have found certain sources of error in roentgen-ray measurements with large air chambers which had not been emphasized before, and have constructed a measuring instrument for practical work which possesses many desirable features.

When roentgen-ray units and standards are adopted officially, the necessary instruments will be kept at the Bureau of Standards in Washington. It will be possible then for any one to have his instruments calibrated there. Perhaps it may even be possible for the Bureau of Standards to provide trained technicians who can make the necessary measurements in different radiological clinics from time to time. This, as previously stated, is very desirable. However, on account of the great distances in this country, it is more practical to have several properly equipped laboratories conveniently located, which can act as standardization stations under the general supervision of the Bureau of Standards. Dr. Glasser and Dr. Portmann have shown how this can be done at the Cleveland Clinic.

DR. A. MUTSCHELLER, Long Island City, N. Y. It appears to me that two points in particular are generally accepted, and one of

these is that errors as large as 50 per cent can easily occur in the radiations generated with mechanical rectifiers, which give no external indication of their presence. For that reason the measuring methods that were described and discussed this afternoon are a necessity. The second point, which I believe has been very eloquently argued right here, is that the methods of measurement, the standardization of instruments and possibly in the final point the agreement as to what unit should be employed, constitute such sources of trouble and cumbersomeness that certainly there is much yet to be desired to make the clinical therapeutist feel comfortable in his laboratory.

Dr. Glasser has tested a large number of machines, but among those there are only a very small number of constant potential equipments, and for that reason I should like to mention here, that during my experience, having tested a large number of constant potential equipments, I have found that the radiation emitted from these equipments, under various conditions, was so uniform and so well defined that I believe the uniformity and reliability of the radiation emitted from constant potential equipment is for all practical purposes satisfactory.

I am sorry that I haven't a slide of the curves which I have made, all under the most varying conditions under which they can be encountered, and all showing a remarkably satisfactory agreement.

I hope that Dr. Glasser and Dr. Portmann may have an opportunity to continue this important work and include in it, in particular, the constant potential equipment. I should further like to say, leaving all other factors aside, that probably the greatest advantage which the constant potential current has in its favor, is the elimination of the necessity of checking up the constancy of the equipment, such measurements are extremely delicate and fallacious and in themselves liable to become sources of error; and then, finally, eliminating all such forms of error in wave forms of primary power current, shifting of rectifiers, and so on. I hope that their future experience will correspond and tally with my experience, to the effect that the use of constant potential brings out advantages in such form as to render the routine of calibrating equipment so much simpler.

Dr. George E. Pfahler, Philadelphia. I, of course, can discuss this subject only from a practical standpoint. I know nothing of it in the terms of the physicists. I believe, however, that our problem will be in part solved if all of these leading physicists who have already done a great deal of work can get together and not only agree upon a unit that will be practical and satisfactory as a unit of intensity for America, but to give us the terms in the units that have already been adopted in Germany and those that have been adopted in France, and then as physicists, who must after all do this work, determine upon some instrument that is reliable to measure this standard unit correctly at all times. Then let all the other instruments be checked up against that and we automatically have a standard. That standard instrument upon which you, as physicists, can agree, can be recommended to the Bureau of Standards, and make it an official thing in Washington, if you prefer. But even if the Bureau of Standards doesn't establish such a unit, if it is established in Cleveland, or in Boston, or in New York, or wherever it is established, and physicists can go to that laboratory and check any instruments you have against that, you in turn can check all the other instruments in our laboratories and we have something to go by. It seems to me if our physicists will, as a body, be appointed to do that, or take it upon themselves to do it, much of our problem will be solved.

Dr. Ernest Gendreau, Montreal, Canada. I want to congratulate Dr. Glasser for one especial idea among many: that is, to harmonize the French and the German units. We are now facing two principal units—the German R and the French R. I think one of the first things to determine is to have one unit out of those two. One is theoretically perhaps more acceptable—the German one—but the other seems now more practical. If, as Dr. Glasser has said, Dr. Solomon only changes the distance at which he standardizes his ionization chambers, the result will be exactly the same, and this will be very practical, the roentgenologists in the whole world having only one unit. Nearly every general practitioner having radium can use Solomon's method, while the value of the German R is not yet universally established.

If we had that standard definitely established and our chambers calibrated, and if we had radium to recalibrate without sending back all these chambers to a central laboratory, I think it would be helpful everywhere.

This question has to be discussed in Stockholm. Perhaps it would be halfway solved, if Dr. Solomon were willing, as it is probable, to change the distance and combine his unit with the German one.

Dr. Preston M. Hickey, Ann Arbor, Mich. I should like to ask some questions of Dr. Glasser. He states that he has calibrated some 130 machines. I should like to ask him if he

could give us a little idea of what constituted the varying factors in those machines—whether due to difference in type, whether due to difference in installation, whether due to difference in the care of machines and the question of leakage, or whether it was due to inherent variations in the tubes employed?

DR. G. W. C. KAYE, Teddington, England. Most of us, I think, regret that events have shown that up to now there is a marked disagreement between the French, German and American units of roentgen-ray intensity. If this question can be solved at the meeting at Stockholm next year, as we hope it will, then on that score alone the Second International Congress will have justified itself. Dr. Glasser's contribution is calculated to further that end.

I am, however, in sympathy with the view that this problem of standardization is one for the physical laboratory and not for the medical worker, who should not be asked to arm himself with elaborate physical instruments. I was in Germany last year and it seemed to me that some of the dosage instruments that were being put forward were much too expensive and formidable for a busy roentgen-ray worker to be bothered with. The right way is, I think, as Dr. Pfahler suggested, for the various national laboratories to take up this problem of standardization and set up standard ionization chambers. The Reichsanstalt in Germany has made a start, we are taking the matter in hand at the National Physical Laboratory, and I understand that the Bureau of Standards will also take a similar step. This plan would avoid needless duplication of expensive apparatus, and any roentgenologist need then only provide himself with a relatively simple ionization chamber or the like which could be calibrated at his national laboratory.

Even those workers, and there are many, who prefer the simplicity of a kilovolt-milliampere system of dosage could standardize their conditions by the help of such a calibrated ionization chamber. I take it that that system is probably sufficiently adequate for most workers, provided they always use the same outfit and vary the conditions as little as possible. With constant potential outfits the system is even more reliable.

Thus all the roentgenologist needs is some kind of simple ionization chamber—a yardstick so to speak—which will enable him to measure dosage in physical units through the medium of his national laboratory.

I should like to add my congratulations to Dr. Glasser for what seems to me to be a valuable contribution to the subject.

DR. M. SOSMAN, Boston. Dr. Glasser said the erythema dose was 1300 electrostatic units. Does that include the secondary radiation or back-scattering from the patient's body; in other words, does it measure the dose with the patient in place and does it include the secondary radiation?

DR. GLASSER (closing). The questions of Dr. Hickey and Dr. Mutscheller can be answered together. The factor which plays the greatest rôle in the inconstancy of the output of the roentgen tube is the wave form of the current reaching the tube. This form should be of the sine wave type but very often is quite distorted. There are many reasons for this. The characteristics of transformers and rectifiers are different, the rectifier may shift on its axis and thus be out of phase, etc. Another important reason for variations in the output of radiation is inherent in the roentgen tubes themselves. Unfortunately the tubes of to-day are not yet constructed so that they produce a uniform output of radiation under identical electrical conditions.

Most of the machines which we have had the opportunity of calibrating, were measured under the actual working conditions which the radiologist wished to employ, that is, with his transformer, rectification, tube, etc., and this explains the great differences to which we referred in our paper.

In regard to Dr. Sosman's question I wish to say that we are now using 1300 electrostatic units per erythema for hard rays including the back-scattering from the patient.

To come to Dr. Pfahler's question, I might say that up to the present time in this country there are only four physicists (Duane, Bachem, Beets and myself) who have determined the electrostatic or roentgen unit. Our units agree reasonably well and therefore it does not seem to me important that the physicists should get together to define their units. As I have said, the results obtained by physicists who have made an absolute determination of the unit with large air chambers of the Duane-Friedrich type, agree very well. Dr. Behnken from the German Bureau of Standards will be here in a few weeks and it is to be expected that we will reach an agreement between his unit and our own roentgen unit. Also Dr. Solomon of France suggests some changes in the definition of his roentgen unit, along lines which we have suggested and we hope that we will also agree.

I think Dr. Failla drew too dark a picture as far as practical dosage instruments are concerned. The two instruments which we have presented in our paper seem to be entirely practical and fool-proof. The first one, the condenser dosimeter has some novel features

which make it possible to determine radium and roentgen doses in R units and its practical use seems to be unlimited. There are certain features which must be simplified before it will be entirely satisfactory for use in the treatment room. The second instrument, which we have shown, closely resembles other well-known instruments, for example, the iontoquantimeters of Friedrich, Solomon, Wulf and others. We have tried, however, to incorporate in this instrument all of the advantages of the other instruments and to avoid objectionable features such as leakage and inflexibility. To make it practical for treatment work it had to be simple and rugged and it had to be constant, i.e., it had to deliver a reproducible unit of dosage under all conditions. The unit of dosage is the roentgen unit previously described, and the constancy can be controlled by radium which may be placed directly in the instrument.

It seems to me that there is very little left to do in defining units and designing instruments. We have selected a unit that is generally accepted, we have tried and are still trying to bring it into agreement with the same unit which has been defined at other places; we have determined this unit again and again with great accuracy by means of a large standard air chamber; we have constructed instruments to transport this unit from the standardization laboratory to treatment room; and we have correlated this physical unit with the biological effect. For practical work, the unit should be generally accepted and transferred to the treatment room by means of well designed instruments and that is up to you.

INFLUENCE OF ROENTGEN RAYS UPON GASTRIC SECRETION*

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THERE have already appeared in the literature a considerable number of communications dealing with the effect of roentgen rays upon gastric secretion, following irradiation not only directly over the gastric area but also over remote regions, the gastric area and the liver being carefully protected. Some of these communications have appeared in connection with investigations of the cause of radiation sickness, others in the effort to determine the usefulness of roentgen rays in the treatment of hyperacidity and gastroduodenal ulceration. However, the reported results have been discordant, and the present paper is offered in an effort to discern the cause of the discordance in the existing reports and to offer further testimony upon which to base a practical conclusion.

A number of possible causes of disagreement in results present themselves at once on perusal of the various papers already published. Some dealt only with low voltage irradiation, others with highly penetrating rays. Particularly with reference to enzyme action, it is apparent that some of the observations were not carried out over a sufficient length of time to permit sound conclusions. Yet in a great many cases it is difficult to explain the contradictory observations of the authors.

REVIEW OF THE LITERATURE

We may divide our review of the literature into several subheads:

Effect on Secretion. Szegö and Rother,[1] who used sham feeding and high voltage irradiation, reported that ordinary doses caused no change in secretion but that heavy doses caused an increase in the amount of secretion followed by a decrease, but with quick recovery to the pre-existing condition. Wächter[2] claimed to have observed increase of gastric secretion in 2 cases of gastric neurosis with normal HCl content, and in 2 cases of anacidity previously long treated with free HCl without effect. However, he also reported no effect in several cases, and a definite decrease in 13 cases. Simonetti[3] claims to have observed constantly an increase in

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the secretion in all of 11 cases, following so-called "stimulating" doses. Portis and Arens[4] thought they observed a transitory stimulation of secretion, as did also Dieterich and Rost,[5] but Ivy and his associates[6] reported careful observations which apparently put an end to the question of any stimulating effect. Professor A. J. Carlson[7] came out with the declaration that "the idea that one can with a given dose of roentgen rays stimulate an organ or gland to increased activity is nonsensical." Definite failure to stimulate gastric secretory activity was also reported by Holzknecht,[8] Frik and Krüger,[9] Bruegel[10] and by Stephan,[11] although the latter is one of the most enthusiastic supporters of the idea that small doses of radiation should have a stimulant effect.

On the other hand, numerous reporters declare that, in general, the effect of irradiation is to definitely depress the gastric secretory function, though they found by no means a constant result. For instance, Kolta[12] found that in only 13 out of 30 human cases was this depression at all important. Dieterich and Rost[5] noted several cases without result from irradiation. There is considerable discrepancy between the results, depending upon whether the experiments were done upon animals or upon human beings. Brocq, Solomon and Oury[13] found that the secretion of dogs was refractory to the action of roentgen rays whereas the secretion of man is easily modified by relatively small doses. Yet one of us (J. T. C.) noted only slight and temporary depression of gastric function in a number of human beings undergoing deep roentgenotherapy. Twelve cases were studied.

Effect on Gastric Acidity. Bruegel,[10] studying 90 cases, reported a reduction in the acidity of the gastric secretion after a dose of 16 to 20 H, employing 3 mm. of aluminum plus 1.5 mm. of hard rubber as a filter, and a focus skin distance of 30 cm. The voltage is not mentioned, but we may infer the approximate voltage from the statement that the treatment was given with a superhard Polyphos instrument. Two areas were employed, one anterior and one posterior, and the treatment repeated in two weeks, so that the total dosage applied to the skin was 20 H units.

Bryan and Dormody[14] secured an appreciable decline in both free HCl and total acid in 2 cases of duodenal ulcer with hyperacidity. Their treatment was continued over approximately a month before the results were secured. Follow-up in these cases has not been published. Szegö and Rother[1] found that heavy doses of high voltage radiation gave briefly increased acid values followed by an even shorter decrease and then by a quick recovery to the pre-treatment curve. Wächter[2] found that the normal acid values were diminished through prolonged irradiation, but his work was done with low voltage and rather thin filter. Miescher[18] reported a fall in the acid concentrating capacity with slow return to normal. However, he used only one animal for the experiments upon which he based his conclusions. Ivy and his colleagues[6] found that 1.6 dog's erythema dose, a very heavy dose (5 times the irradiation used by us), caused achylia, with a return to normal acidity in three to four weeks, although the total quantity of secretion remained reduced. The chlorides of the gastric secretion were not affected by irradiation. Portis and Arens[4] also reported achylia, or almost achylia, from irradiation over the stomach itself, but make no comment on the duration of the result.

Some of the most precise experiments on human beings have been reported by Bensaude, Solomon and Oury.[15] They employed fractionated doses of 2.5 H units each, with one or two séances per week, voltage 120,000, filter 5 mm. aluminum, focus skin distance 22 cm., size of field 10 cm. in diameter. The dose was measured by an ionometer. In 3 of the patients a marked erythema was produced between the eighth and the twelfth sitting, necessitating a posterior port of entry in place of the anterior area employed during the first sittings. Under the action of a single dose of 2.5 H units, one-third of the cases showed a sharp fall of acidity, more often one hour after the irradiation. This depressant action was of very short duration because the following day the acidity returned to its previous proportion. In two-

thirds of the patients, on the contrary, the acidity was not modified by the application of a single dose of 2.5 H units. Under the action of several of these doses at three to eight day intervals, the variations of the gastric juice have been more frank. In 55 per cent of the observed cases, there was noted a rapid fall of acidity; in 25 per cent a light drop, and in 20 per cent no modification at all was detected by the ordinary means of chemical investigation. The diminution of free hydrochloric acid was greater than that of the total acidity and the drop of free HCl was also more lasting. Kolta[12] declared that hyperacidity was susceptible to the influence of the roentgen rays only in a portion of the cases; and this action was not constant. He also found that there was no parallel between the subjective and the objective conditions. Dieterich and Rost,[3] repeating the experiments on dogs with gastric and duodenal fistulae, found no great decrease of acid on moderate or strong irradiation to other parts of the body when the stomach and the liver were protected, and even direct irradiation of the stomach with large doses did not always decrease the acid and ferment values.

Effect on Enzymes. Lawrence[16] reported no particular effect of irradiation on enzyme action. Roth and Morton[17] found, *in vitro*, no effect from irradiation of pepsin solutions. Szegö and Rother[1] noted especially marked increase of rennin after very heavy dosage, followed by decrease and rapid return to pre-existing values. Simonetti[3] states that the pepsin measured in 12 patients after the ingestion of a definite amount of albumins, was found increased in 8 cases, diminished in 3 and unchanged in one. Miescher,[18] on the other hand, observed that the pepsin was at first unaffected, but suddenly fell abruptly after eleven or twelve days and only slowly rose again; the pepsin curve did not begin to drop until the other curves had begun to rise again. Ivy and his associates[6] found a marked lowering of the pepsin secretion, and they also observed that the acid curves were affected before the pepsin. Bensaude and his colleagues[15] found that in all cases a single treatment, which was sufficient in one-third of the patients to cause a sharp but temporary fall of acidity, was insufficient to modify the proportion of pepsin in the gastric juice; but with continued treatment the drop in the proportion of pepsin though produced more slowly, occurred much more regularly than the diminution of acidity.

Effect on Spasm. In 1916 Wilms[19] reported that he had observed some benefit in treating pyloric spasm with roentgen rays and he explained the diminished spasm as the result of lowering of gastric acidity. Lenk[20] believes that there is a spasmolysis produced by the roentgen rays but it is very hard to explain just how such a spasmolysis occurs. A direct action on the muscle cells is improbable in view of their low degree of sensitiveness to irradiation. Anatomical injuries of the normal muscle can only be brought about by excessively high doses, and functional impairment is not known at all. He thinks, therefore, that the effect must be one by way of nerve injury. But histologically demonstrable injuries in nerve tissue can be brought about only by enormously large doses of rays which cannot be used in clinical practice. On the other hand, a functional effect of irradiation is known in normal nerves (in decreased sensitiveness of the cornea, and in decreased sensitiveness of the buccal mucosa, as shown by the present writers[21]), and particularly in diseased nerves. It is well known that certain neuralgias are often favorably influenced by radiation therapy.

If it is true that irradiation has a spasmolytic effect, then we have a basis for the radiation treatment of some gastric and duodenal ulcers, and an explanation of the symptomatic relief which is afforded these cases, according to reports which are fairly numerous in the literature. One of the theories of the development of ulcer assumes a spasmophilia of the muscularis mucosae of the gastric wall. Spasm of this muscle layer leads to local ischemia and later to nutritive disturbances and necrosis. At any rate spasm is one of the principal accompaniments of ulcer. The complete and rapid disappearance of an ulcer niche which has frequently been observed might be interpreted as due to the relaxation of spasm at the orifice of the niche, and the relaxation of conditions of spasm offers a

plausible explanation for the quick cessation of spontaneous pain.

Radioresistance. Several of the authors already referred to have observed what they have interpreted as a tolerance to radiation, which has come on at a more or less distant period after the beginning of the treatment. Bensaude and his colleagues[15] state that though tolerance to roentgen rays has been rare enough in the course of their researches, nevertheless it was noticed in some cases. This tolerance was characterized by the re-elevation of the gastric acidity in spite of the application of new doses of radiation. Miescher[18] thought that the stomach might develop a certain resistance to radiation.

AUTHORS' EXPERIMENTS

As is well known, gastric secretion during digestion consists of two quite distinct phases: First, the preparatory, psychical, or appetite phase, produced by the appetite; second, the chemical phase produced by the action of extractive substances and absorbed products of digestible food upon the gastric glands.

The first phase, lasting in dogs about two hours, gradually merges into the second phase which begins one-half to one hour after the taking of food. The second phase does not in any way influence the first phase, but the first phase has a strong influence upon the second, because the first prepares the substances which call forth the second. In order to form a correct and complete conception of the action of roentgen rays upon gastric function, one must, of course, investigate the influence of these rays upon both phases taken separately and together.

The Psychical Phase. The problem in regard to the psychical phase is most conveniently solved upon dogs with a gastric fistula and esophagotomy; the second phase is best studied in dogs with some form of an isolated stomach pouch. For the first phase we used sham feeding after the method of Pawlow. The food does not reach the stomach and accordingly we deal only with the first phase of gastric secretion—that due to psychical impressions or appetite.

In these first phase experiments special attention was paid to exactness of observations, as they are strictly of a quantitative nature. The quantity and kind of food used in the sham feeding, the duration of the sham feeding, and all other conditions were so far as possible kept constant in all the investigations. All experiments were performed twelve hours after the last feeding when the dog's stomach was empty and gastric secretion had ceased. The dogs were weighed daily and the general condition of health carefully observed.

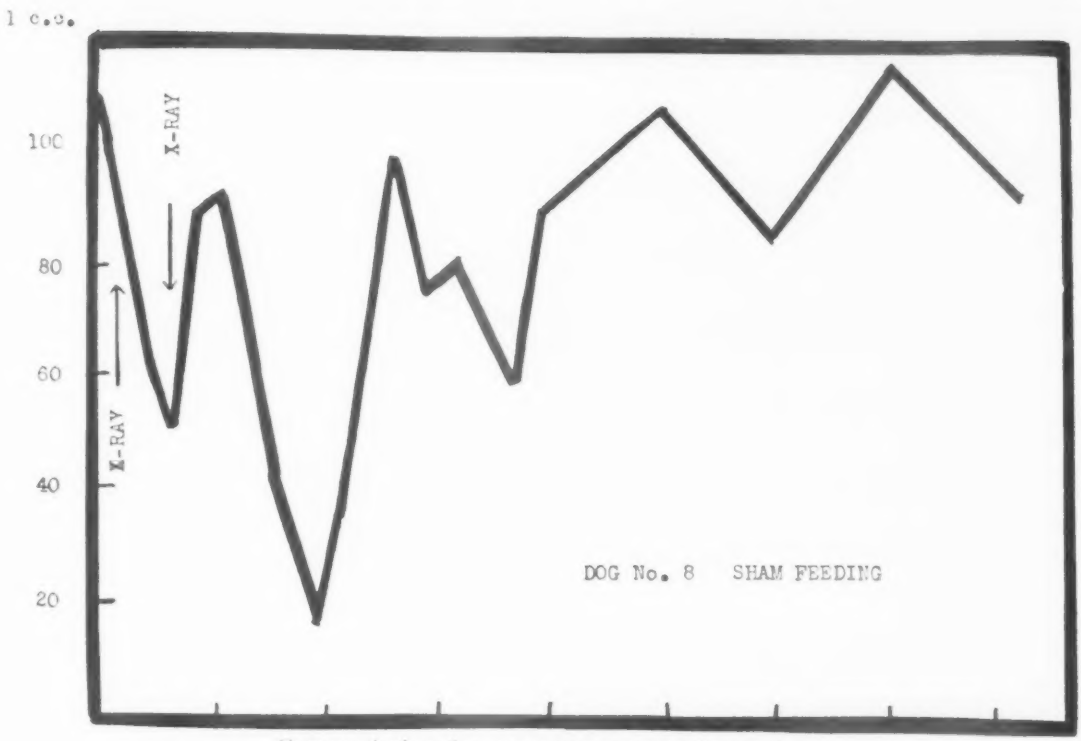
When the normal secretory work of the stomach was well established, the dogs were exposed to roentgen irradiation under the following conditions of treatment:

1. In the first series of experiments the dogs received 500 milliampere-minutes, given at the rate of 25 ma. per minute over a field 12 × 14 cm. in diameter, through a filter of 1 mm. of copper and 1.2 mm. of aluminum, at a focus-skin distance of 50 cm. and with a potential of 200 kv. The dose was divided into two sittings three days apart, August 22 and August 25.

2. In the second series the same conditions of treatment were maintained except that the total dosage was reduced from 500 to 450 ma-min., administered in two sittings, December 27 and December 29.

In Table I and Curve I are recorded the results of the first series of experiments on the psychic phase of gastric secretion. It is seen that the quantity of gastric secretion was strongly diminished by irradiation, the minimum being reached ten days after the second treatment. The rate of gastric secretion then began to improve, becoming normal in two months after the irradiation. It is seen that the acidity and pepsin contents were not affected by the roentgen-ray treatment. The general condition of the animal was good throughout the investigation. There was a loss of one kilogram of weight during the first two weeks following the treatment, but this was regained a little later.

In a second series of treatments, the results obtained were identical except that the decrease in the quantity of gastric secretion was only about 50 per cent (see Table II and Curve II for typical results).



CURVE I. Action of roentgen rays upon gastric secretion.

TABLE I

THE ACTION OF ROENTGEN RAYS UPON GASTRIC SECRETION

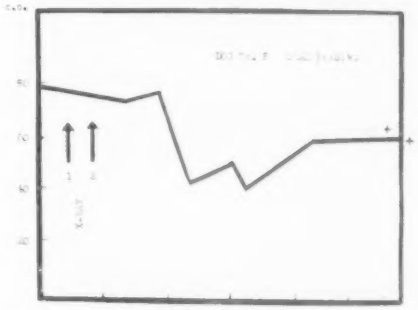
(Esophagotomy and Gastric Fistula)

In all experiments the gastric juice was collected during 30 min. sham feeding

Date of Experiment	Quantity of Gastric Juice in c.c.	Acidity in Per Cent HCl	Pepsin in mm. (After Mett)
July 16 (Normal)	116.0	0.535	4.6
Aug. 20 (Normal)	108.6	0.495	6.1
Aug. 22	Roentgen-ray Treatment		
Aug. 23	66.2	0.486	5.1
Aug. 24	54.5	0.477	5.6
Aug. 25	Roentgen-ray Treatment		
Aug. 26	91.4	0.535	6.1
Aug. 28	95.7	0.513	6.1
Aug. 30	48.8	0.495	5.6
Sept. 2	27.9	0.531	6.6
Sept. 4	11.6	0.459	6.1
Sept. 6	33.8	0.522	6.1
Sept. 9	100.3	0.575	5.1
Sept. 11	78.8	0.531	5.1
Sept. 15	86.7	0.585	4.6
Sept. 19	60.1	0.522	5.1
Sept. 26	89.3	0.549	...
Oct. 9	110.5	0.566	...
Oct. 19	79.6	.....	4.6
Nov. 4	124.8	0.522	4.5
Nov. 15	97.7	0.553	5.1

On a second dog the same method was used and the results were identical to those observed in the first animal.

In a third animal instead of sham feeding, showing of food was employed as a



CURVE II. Action of roentgen rays upon gastric secretion.

means of exciting the psychical secretions. The results were the same as on the dogs fed by sham feeding.*

In summarizing the results of our numer-

* The experiments presented in this article were later repeated on 2 more dogs with gastric and esophageal fistulae. The results of the new experiments were quite identical with the previously obtained data and tend to confirm our findings on the action of roentgen rays upon gastric secretion.

TABLE II
THE ACTION OF ROENTGEN RAYS UPON GASTRIC SECRETION
(Esophagotomy and Gastric Fistula)
In all experiments the gastric juice was collected during sham feeding lasting 30 minutes

Date of Experiment	Quantity of Gastric Juice in c.c.	Acidity in Per Cent HCl	Pepsin in mm. (After Mett)
Dec. 24	77.7	0.495	4.6
Dec. 27	Roentgen-ray Treatment		
Dec. 29	Roentgen-ray Treatment		
Dec. 31	74.9	0.504	5.1
Jan. 2	76.1	.....	...
Jan. 4	41.5	0.468	4.6
Jan. 8	48.8	0.509	5.6
Jan. 9	40.4	0.450	6.1
Jan. 14	62.7	0.540	5.1
Jan. 22	63.6	.....	...

ous experiments on the *psychical phase*, it was evident that the quantity of secretion

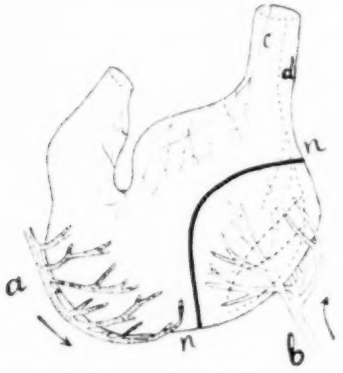


FIG. 1. Isolation of a portion of stomach after Heidenhain. *a* and *b*. Arteriae supplying different portions of stomach. *c* and *d*. Branches of vagus (left and right). *n-n*. Line of incision. Sympathetic nerves enter the isolated portion of stomach with blood vessel *b*. During the operation the parts *n-n* of the large (main) stomach are sutured together.

was strongly diminished, although the properties of the gastric juice remained unchanged. The decrease of secretion was only temporary, secretion returning later to normal. The secretion reached a minimum about ten days after treatment and returned to normal within two months. The acid and pepsin contents of the juice during the psychical phase were not affected by the irradiation. At first the dogs lost slightly in weight, but later returned to normal weight and their good condition was maintained throughout the remainder of the investigation. The results were the same, whether the food was actually given to the animals by sham feeding, being returned to the food platter through the esophagotomy opening, or whether it was merely shown to the dogs as a means of exciting the psychical secretions.

The Chemical Phase. For studying the second phase, we prepared dogs with the isolated stomach pouch after the method of Heidenhain (Fig. 1). In this operation the branches of both vagus nerves going to the part of the stomach to be isolated are cut; so that Heidenhain's isolated stomach pouch is altogether deprived of psychical influences and thus the experiments with this type of stomach pouch are quite fit for our purpose. For tracing the influence of roentgen rays upon the secretion formed as the result of both the psychical and the chemical phase, it is also desirable to employ a type of isolated stomach pouch which preserves the vagus branches, and for this purpose we employ a dog with a pouch of the Pawlow or the Boldyreff type.

In these experiments the rate of secretion of the gastric juice was measured in the following manner: The dog, fed twelve to fourteen hours before the experiment, was put in a stand and the secretion observed for thirty to sixty minutes to make sure that the digestion in the stomach was completed and that there was no spontaneous gastric secretion. After that, the dog was given a meal consisting of 150 grams of raw meat, 100 grams of bread, and 300 grams of milk, and the secretion was measured every thirty minutes for six hours. Usually at the end of six hours the gastric secretion had not yet ceased but continued for an hour to an hour and a half longer. However, the period of six hours included the most of the secretion on the food used and served as an exact measure of the rate of secretion. It would have consumed too much time to measure the secretion up to the end in every experiment. The following table (Table III) represents a protocol of one of the experiments in which the secretion was observed up to the end of secretory activity. Usually in such experiments the reaction in the isolated stomach was alkaline soon after the secretion had ceased.

TABLE III

GASTRIC SECRETION FROM HEIDENHAIN ISOLATED STOMACH. FED TWELVE HOURS BEFORE EXPERIMENT

Time in $\frac{1}{2}$ Hr.	Quantity of Juice in c.c.	Acidity in Per Cent HCl	Pepsin in mm. (After Mett)	
I	0.1			before treatment.
	Dog Given 300 c.c. of Milk to Drink			
I	0.8			
II	1.6			
III	2.7	0.347	2.54	
IV	4.8			
V	2.7			
VI	2.0			
VII	1.7			after treatment.
VIII	1.4			
IX	1.6			
X	1.8	0.328	2.54	
XI	0.7			
XII	0.1			
XIII	0			
Sum	21.9			

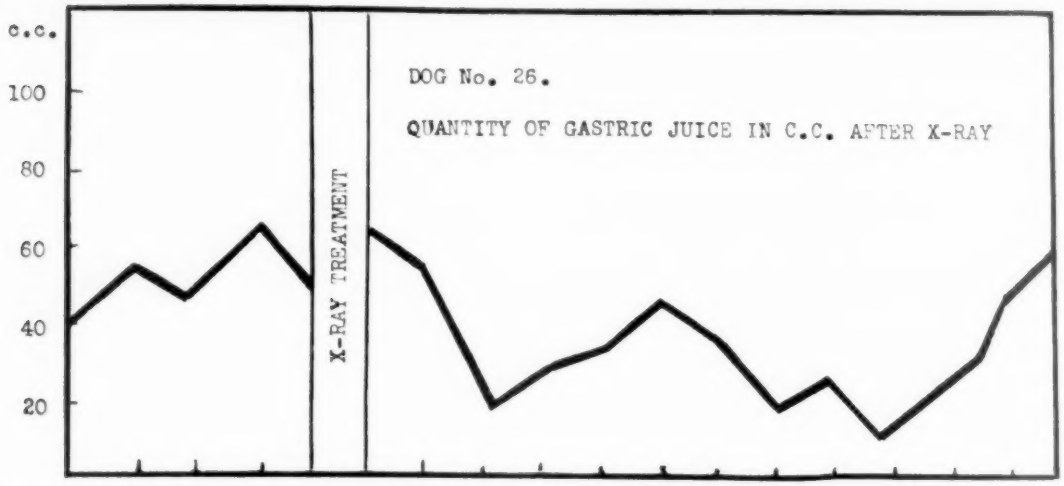
These experiments were conducted with great care and special attention was paid to the conditions under which they were performed. The quantity and the kind of food eaten, the duration of feedings and all other conditions were kept constant. After the normal rate of secretion had been established, the dogs were exposed to roentgen-ray treatment, the technique of the application being identical with that previously stated. The results of the experiments are shown in Table IV and Curve III (quantity of gastric secretion) and in Table V and Curve IV (acidity and pepsin content).

In summarizing the results of the investigation on the *chemical phase* of gastric secretion following roentgen-ray treatment, it was evident that the quantity of gastric juice was decreased but later slowly returned to normal, about eight weeks being required for the return. The secretion began later after roentgen-ray treatment than in the experiments on the psychical phase; it was retarded an hour or more. This is to be explained not only by the direct effect of irradiation upon the stomach but also by the effect upon the intestines; for the chemical phase depends in part upon absorption in the intestine,

TABLE IV

QUANTITY OF GASTRIC JUICE IN CUBIC CENTIMETERS AFTER ROENTGEN-RAY TREATMENT HEIDENHAIN'S ISOLATED POUCH

Dates	1st Hr.	2d Hr.	3d Hr.	4th Hr.	5th Hr.	6th Hr.	Total
	Normal (before Treatment)						
June 5	7.6	5.6	6.7	8.8	8.1	9.2	46.0
June 8	1.7	3.6	16.0	12.2	10.3	8.4	52.2
June 10	6.3	1.5	7.8	8.8	13.3	11.4	49.1
June 15	7.8	1.4	5.3	15.3	13.1	18.6	61.5
June 18	1.5	2.0	4.9	10.4	10.9	17.9	47.6
June 19			Roentgen-ray Treatment				
June 21	8.8	3.9	7.6	7.9	18.2	15.3	61.7
June 23	1.9	3.1	9.8	16.2	12.6	10.1	53.7
June 26	0	0.2	4.9	8.1	10.7	7.4	31.3
July 3	7.0	2.5	7.1	6.1	8.6	6.3	37.6
July 5	4.4	1.0	1.1	11.5	9.4	12.1	39.5
July 9	4.1	1.2	7.3	14.4	9.4	12.0	48.4
July 13	5.5	3.0	3.8	3.6	15.9	12.0	44.1
July 15	3.6	1.8	4.2	10.5	10.5	7.5	38.1
July 17	1.7	0.2	3.8	8.1	9.2	9.4	32.4
July 20	6.6	1.7	0.4	7.7	13.1	8.5	37.9
July 24	0.8	1.7	4.2	6.4	7.9	7.1	28.1
July 28	3.4	3.5	5.0	7.9	6.8	5.9	32.5
Aug. 4	0.5	1.9	15.0	....	11.5	10.0	38.9
Aug. 12	0	1.4	13.3	15.0	10.5	12.3	52.5
Aug. 14	3.4	2.2	11.5	16.2	14.5	9.4	57.2

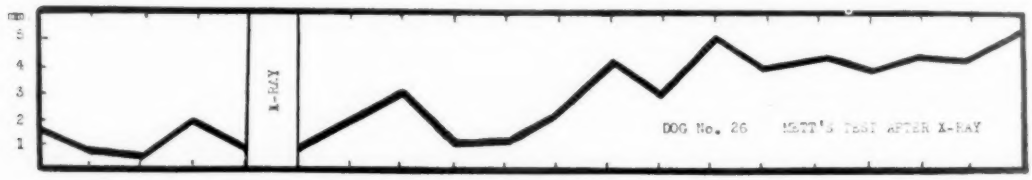


CURVE III. Action of roentgen rays upon gastric secretion. Heidenhain isolated pouch; chemical phase of secretion.

TABLE V

QUALITY OF GASTRIC JUICE AFTER ROENTGEN-RAY TREATMENT
HEIDENHAIN'S ISOLATED POUCH

Dates	Hours I–II		Hours III–IV		Hours V–VI	
	HCl Per Cent	Mett mm.	HCl Per Cent	Mett mm.	HCl Per Cent	Mett mm.
	Normal (before Treatment)					
June 5	0.548	2.54	0.529	2.03	0.548	1.78
June 8	0.365	1.78	0.493	1.78	0.493	2.03
June 10	0.381	2.03	0.438	1.52	0.511	1.52
June 15	0.310	3.56	0.548	1.52	.....	2.03
June 18	.....	....	0.383	2.03	0.475	2.03
June 19			Roentgen-ray Treatment			
June 21	0.456	1.52	0.456	2.03	0.475	2.03
June 23	0.310	3.04	0.511	2.54	0.475	2.48
June 26	.....	....	0.292	3.56	0.56	3.05
July 3	0.274	3.05	0.365	2.03	0.328	2.03
July 5	.....	....	0.383	2.03	0.420	2.03
July 9	.....	....	0.475	2.03	0.475	3.05
July 13	0.110	5.08	0.365	3.56	0.456	3.56
July 15	0.310	40.6	0.402	3.05	0.438	3.05
July 17	.....	....	0.365	4.06	0.402	4.58
July 20	0.347	4.06	0.383	3.56	0.365	4.06
July 24	.....	....	0.347	3.56	0.436	3.56
July 28	.....	....	0.438	3.05	0.438	3.56
Aug. 4	.....	....	0.365	4.06	0.420	3.56
Aug. 12	0.365	5.08	0.456	4.06	0.493	4.06



CURVE IV. Action of roentgen rays upon gastric secretion.

and this is also apparently affected by the treatment. In our observations we found the acidity practically unchanged and the amount of pepsin increased. It seemed to us that the appetite of the animals perhaps even improved after roentgen-ray treatment(!). The general condition of the animals was good throughout the investigation, a small loss in weight at first noted being regained shortly after the treatment. At first one sometimes observed vomiting and secretion of bloody mucus (from the isolated stomach), but the quantity of mucus secreted did not increase.

It was interesting to observe that the age of the animals apparently had something to do with the ease of recovery from the effects of irradiation; the secretory and other phenomena under observation in young dogs returned to normal sooner than it did in old ones.

We should not forget that when the region of the stomach is exposed to irradiation, the stomach is not the only organ affected; the adjacent small intestines, pancreas and liver are also acted upon. One of us (J. T. C.) with Warthin, has already published observations relating to the effect of irradiation upon the liver.[22,23]

We here record an interesting and very striking incident: a rebellious ulcer 2.5 cm. in diameter around the fistula from the isolated stomach on one of the dogs was rapidly cured within three weeks after the roentgen treatment, though it had resisted treatment for ten months before the roentgen ray was applied. Apparently the exposure to the roentgen ray caused this healing.

The question of the *treatment of hyperacidity and peptic ulcer* with irradiation has been before us for some time, but up to this moment very little reliance has been placed upon such a mode of therapy. Regaud, Nogier and Lacassagne[24] reported complete atrophy of the fundal glands of a dog as the result of 63 H given through 2 or 3 mm. of aluminum in five sittings during fifteen months. Ghilarducci[25] noted the formation of epithelial ulcers in the stomachs of dogs after irradiation. On the other hand, Strauss[26] claims to have observed no changes in the epithelial lining of the stomach, and consequently denies the possibility of any direct influence on gastric secretion by means of roentgen rays. He explains the results noted in relation to gastric secretion by an increase of the H-ions and consequent calcium retention. Histological examination, made for one of us (J. T. C.) by A. S. Warthin, of mucosa from several stomachs, post mortem, following heavy irradiation for therapeutic purposes, has failed to show marked changes attributable to the irradiation. This is in keeping with the fact that one of our patients suffering from carcinoma of the thyroid gland, treated by the older technique during eighteen months beginning thirteen years ago, and who is still alive and well, has at no time in the last ten years shown a hypometabolic rate although she has been tested at frequent intervals. Miescher[18] reports the case of a dog which received such high dosage that the skin was depilated and even showed incipient telangiectases, which exhibited a complete *restitutio ad integrum* of gastric function in spite of the intensive irradiation. This restitution was shown not only by the gastric secretory curves, but by post mortem examination which revealed macroscopically and microscopically entirely normal gastric mucosa in the Pawlow stomach.

CONCLUSIONS

It seems, therefore, that high voltage, deep roentgen-ray treatment acts only upon the functional activity without destroying the vitality of the digestive glands, which are fairly radioresistant, and that any result obtained in the treatment of a gastric or duodenal ulcer is likely to be of only transient and not lasting value. This is our own experience as well as that of Samuel and Bowie,[27] Simonetti,[3] Ivy and his colleagues.[6] It is further evident that even a temporary beneficial result should not be expected in all cases. It is noteworthy that an increase in the acid values of the gastric secretion is by no means a constant finding in gastric and duodenal ulcer; and, even when this occurs, it is now recognized that the cause is not an increased production of acid but rather an increased secretion, having a close relation to the question of

stasis. Pyloric spasm is one of the conditions commonly associated with peptic ulcer. In view of the existing uncertainty as to the genesis of ulcer and in view of the facts above cited, a definite and certain foundation for the roentgenotherapy of ulcer has not yet been established, though it is possible to regard it as a measure of occasional benefit in the treatment of symptoms. It is not a method of treatment which appeals to us.

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HOURLY VARIATIONS IN EFFECT OF EQUAL ROENTGEN-RAY DOSES ON GROWTH OF VICIA FABA SEEDLINGS*

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DURING the course of an experiment on the effect of roentgen radiation on young seedlings, it was noticed that the response of the seedlings to the irradiation varied considerably depending on the time of irradiation. Mottram[1] has shown that if the same dose of radiation (from radium) be given to the root tips during the day and during the night, that much greater effects are obtained in those roots which were irradiated during the night. Inasmuch as it is known that the cells of these roots undergo mitosis at night, the effect has been attributed by him to mean that cells in the process of division are more affected than other cells by the same dose of radiation. We obtained results similar to Mottram's in that roentgen irradiation during the night is more effective on growing seedlings (*Vicia faba*) than day irradiation. In addition, we found that there was considerable variation in growth following irradiation at different times of the day. It was decided, therefore, to irradiate with roentgen rays, some young seedlings at intervals of one hour over a period of twenty-four hours in order to determine the time of maximum and minimum reactivity or response of the cells to irradiation.

EXPERIMENTAL

It was first necessary to determine the minimum dosage which would stunt the growth of the seedlings without killing them. With a Coolidge tube operated at 120 kv., 10 ma., and a distance of 20 cm. from the target of the tube to the seedlings it was found that three minutes of irradiation was a suitable dosage to stunt the growth of young plants whose roots were about 1 cm. in length. This dosage was used throughout the entire work. Shorter time of irradiation had too little an effect to be measured, considering the individual variation among the seedlings. With longer periods of irradiation the seedlings died after two or three days. The radiation was in all cases unfiltered except for the gauze over the seedlings.

Having decided upon three minutes' exposure as a suitable dosage, we exposed the seedlings in various stages of development to this amount of radiation in order to determine if the age of the plant had any influence. For this study beans and seedlings were divided into several groups representing various stages of growth; namely, No. 1, dry beans; No. 2, the beans which had been placed in damp gauze for forty-eight hours but which showed no external change; No. 3, those which had roots 2 mm. up to 1 cm. long; No. 4, the seedlings which had developed the thin side rootlets, and No. 5, after the whole plant was 10 cm. or more in length. These were all irradiated with the same dosage (3 min.) and the growth followed for two weeks. The results are as follows: Groups No. 1 and No. 2 showed little or no effect of the irradiation; No. 3 showed a very marked stunting of growth. The entire growth was retarded but what was most marked was the failure of the side roots to develop. This result of the irradiation was observed several times subsequently, either the side roots did not develop at all or they made their appearance as slight protruberances on the main root, never reaching a length of 1 cm. and in no way comparable to the controls or to the growth as in group No. 4. No. 4 also showed a definite retardation of development but not so marked as No. 3. The side roots continued to grow as did the main root but they were not so extensive as the controls. Group No. 5 showed little or no effect of the irradiation. From these results we estimated that the irradiation was most effective during the time when the roots were first

[1] J. C. Mottram. *Archives Middlesex Hosp.*, 12th Cancer Report, 1913.

* From the State Institute for the Study of Malignant Disease, Buffalo, N. Y., Burton T. Simpson, M.D., Director.

visible and before the appearance of the side roots. In subsequent work only those seedlings which had reached this stage were used.

For the study of the influence of irradiation over a period of twenty-four hours several hundred beans were germinated between layers of sterile gauze, moistened with distilled water, until the roots were about 1 cm. long. All unhealthy or backward seedlings were discarded, only those

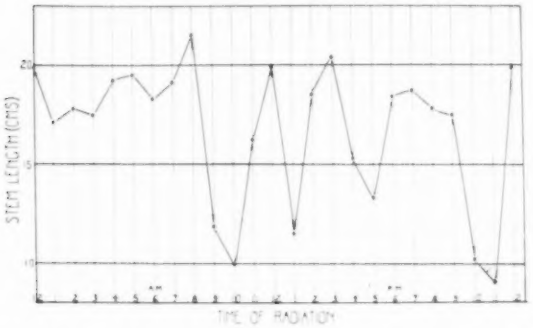

CHART 1. Hourly effect of irradiation as determined by length of seedlings eleven days after irradiation.

whose growth was the same were used. These were divided into groups of 10 and placed in shallow dishes between layers of gauze. For irradiation each dish was placed on a block of paraffin beneath the roentgen tube and irradiated with the dosage as noted previously, 120 kv., 10 ma., 3 min., 20 cm. distance. In this manner a different group was irradiated each hour for twenty-four hours. This was repeated with five sets of seedlings.

Following the irradiation the beans were transferred to a large shallow trough suitably divided into compartments so that the various groups could be kept separate yet be under, as far as possible, the same conditions of temperature, dampness and light. Controls accompanied the irradiated beans and were also placed in separate compartments in the same trough. The growth was followed for two weeks.

For the first set of seedlings measurements of the roots were taken each day but since the individual variation is very large the subsequent sets were measured only at the end of two weeks. Instead the appearance of the plant as a whole was taken as an indication of its condition.

RESULTS

The results of the effect of hourly irradiation on the five sets of seedlings agree very well and indicate that there are four periods of the day when the seedlings are very sensitive to irradiation. From 9 to 10 A.M. and from 10 to 11 P.M. are the periods of greatest sensitivity. At 1 P.M. and at 5 P.M. are the other two periods of somewhat lesser sensitivity.

There are also five periods of the day

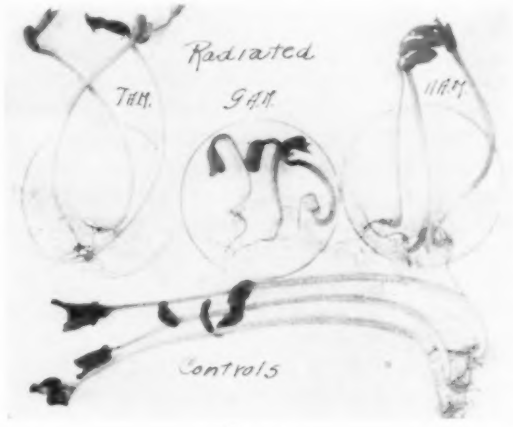

FIG. 1.

when the seedlings are not markedly affected by the irradiation; they are at 12 midnight; 8 A.M., 12 M.; 3 P.M. and at 7 P.M. When exposed at these periods the seedlings show but little diminution in growth. For Chart 1 the length of the seedlings days after the irradiation is plotted against the time of irradiation. This chart shows these periods of greatest and least sensitivity toward roentgen radiation.

Kellicott[1] says that the periods of greatest cell division in onion tips are at 1 P.M. and at 11 P.M. These periods agree very well with two of our periods for greatest sensitivity of the *Vicia faba* seedlings. He also says there are two periods of minimum cell division at 3 P.M. and at 7 A.M. These correspond to two of our periods of minimum response or effect.

Figures 1 and 2 are photographs of the bean seedlings eleven days after irradiation showing the difference in the growth when irradiated at different times of the day.

[1] Kellicott, Wm. E. The daily periodicity of cell division and of elongation in the root of *Allium*. *Bull. Torrey Bot. Club.*, 1904, XXXI, 529.

Further confirmation that it is the cell which is undergoing or about to undergo mitosis which is sensitive to irradiation and which is responsible for the retardation of growth could be obtained by shielding from the radiation that part of the seedling in which these cells are located, namely, the root tip.

Seedlings with roots about 1 cm. long were selected and divided into three groups I, II, and III. Groups I and II were to be irradiated and Group III to serve as control. The tips of the roots in Group I were inserted into small lead cylinders (2 mm. wall), the openings of which were just large enough to admit the root tips. Groups I and II were then irradiated simultaneously under the same conditions as before.

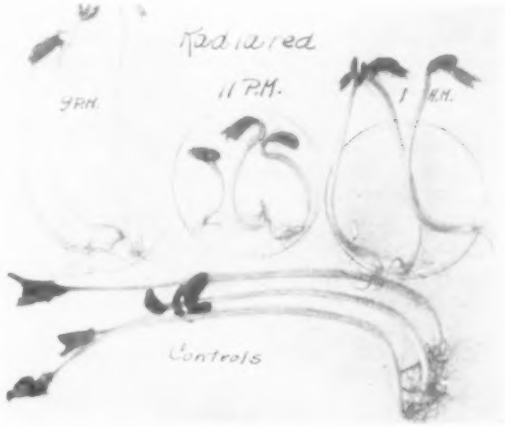

FIG. 2.

Figure 3 shows the appearance of the beans three days after the time of irradiation. The seedlings whose root tips were covered with lead showed normal growth as compared with the controls with the exception, as can very readily be seen in the photograph, that the main root of these seedlings grew considerably longer than the main roots of the controls. The unprotected seedlings had their growth retarded in the usual manner.

SUMMARY AND CONCLUSIONS

Vicia faba seedlings when irradiated with unfiltered roentgen rays in doses sufficient to stunt but not kill the plants, show their greatest reactivity or sensitivity to the irradiation at 10 A.M. and 11 P.M., and at 1 P.M. and 5 P.M. Two of these periods correspond very well to the time when the cells are undergoing division according to Kellicott. There are also periods of the day when the seedlings show the least sensitivity.

When irradiated dry or after being germinated between damp gauze for twenty-four to forty-eight hours before the external appearance of the root tip, the seedling shows no effect of the irradiation.

FIG. 3. Effect of covering root tips with lead when exposed to irradiation: 1, control; 2, irradiated; 3, irradiated with lead around root tip.

Also after the seedlings have developed side roots the response to irradiation is not nearly so marked as when irradiated during the period of growth between these two limits, the appearance of the root tip and the appearance of the side rootlets. During this period the seedling is at its maximum sensitivity to irradiation, also the irradiation represses the formation of the side rootlets. The sensitivity decreases with increasing age of the plant.

Covering the root tip with lead and exposing the remainder of the young plant to roentgen radiation causes but slight diminution in the growth of the plant, whereas the unprotected plant given the same dose shows a marked stunting of growth.

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Information of interest to all readers will be found on page ii.

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EDITORIALS

PHYSICAL FACTORS AND THEIR RELATION TO IRRADIATION

IN the practice of medicine, all tendencies toward the "Science" and away from the "Art" are probably worthy. All efforts to replace empiricism by scientific study of disease phenomena and therapeutic measures, from cause to effect, are steps forward. Yet the very introduction of the semblance of exactness into one factor of a therapeutic situation, the other factors of which in the present state of our knowledge are incapable of being calculated with mathematical precision, carries the danger of inculcating a false sense of therapeutic assurance in those unqualified for critical evaluation through lack of an extensive clinical background.

Ever since the introduction of short wave roentgen-ray therapy we have heard much of Angström units, intensity measurements, depth doses, distribution charts and even occasionally of "carcinoma" and "sarcoma doses" of radiation. Physicists rightly occupy a prominent place at meetings of roentgenologists, and papers prepared by roentgenologists themselves are ofttimes replete with charts and tables of physical measurements. We need the help of the physicist even though we may listen to the heretical whisperings of some of his associates who tell us that no two ionization chambers, even in the hands of capable physicists, were ever known to return identical measurements.

The roentgenologist who places too great reliance upon physical factors raises doubts in our minds when he illustrates his paper with charts showing incontrovertibly that in his series of cases every nook and cranny of the pelvis has received a "cancer dose" of radiation, yet in his summary shows five-year results which are, after all, in direct relation to the clinical characteristics of the disease when treated; and, in the most favorable column, far, far short of the 100 per cent achievements which the charts would seem to indicate.

So long as physical measurements are assessed at their just value, a value comparable to the investigation of the pharmacologist in drug therapeutics, they will constitute a definite and valuable addition to the sources of the radiotherapist. But if too much enthusiasm over ionization chambers leads anyone to neglect what goes on inside the patient, and this is something which, after all, depth dose calculations do not tell us, it is bound to prove a deterrent to progress. A physician practicing radiotherapy who finds himself possessed of a fuller and more ready knowledge of physics than of pathology, and to whom the electroscope is more familiar than the microscope makes doubtful therapeutic progress.

It is apparently not at all certain that the shortest possible wave length has the greatest therapeutic value; in fact, clinical impressions, quite as much as technical difficulties, seem to have led a retreat from 250 kv. or 280 kv. to 200 kv. as the optimum treatment voltage, nor is it evident that the best end-results follow the maximum possible depth dosage short of destruction. Under working conditions, the variations in radiation output are infinitesimal as compared with the mutations of malignant disease.

Charts, curves, wave length measurements are valuable only if it is recognized that they tell a part, and rather a small part of the story. One cannot but feel that the key to progress in our therapeutic activities lies primarily in our training and experience as physicians, and that we shall profit more from a study of pathological physiology from every possible angle,

centering of course about its response to radiation, than from too implicit reliance upon applied physics.

CHARLES D. ENFIELD, M.D.

MEDICINE—A SCIENCE AND AN ART

A former president of the American Medical Association in an address* as president of the Chicago Institute of Medicine, gives an unusually clear presentation of the two aspects of the successful practice of medicine, its background of scientific knowledge and the art of applying that knowledge to the prevention, alleviation and cure of disease. The concluding paragraphs of that address are as follows:

"Is it not possible to have the art and science of medicine in proper proportion? It is possible; that is what I am pleading for. But it is not possible if the chief emphasis is laid on science. The competent physician must be a man who, with a background of science, practices an art with skill that he has gotten through technical training. But the science of medicine is not to be emphasized with him and the art minimized. Experience shows that, except for the rarest man, choice has to be made between these two mistresses. It is not possible to give equal devotion to both and attain one's highest potential success with either. Both are too exacting; their demands are too large for a man to satisfy fully either one without failing somewhat to satisfy the other. For example, a full-time surgeon in a teaching position with the emphasis on research is a poor substitute in everyday emergency surgery for the physician with a large surgical practice. To take what I fear he might regard as a lowly comparison, he is apt to be not so skilful in handling fractures as the industrial physician with a large experience of them. And the students of such teachers are likely to be equally inexpert for these practical jobs. The most dangerous difficulty that one sees of this sort is the attitude that scientific training and laboratory knowledge can take the place of clinical experience and render it superfluous in practice. This is the ground for innumerable mistakes that are seen in practitioners whose training should have made them superior to such mistakes. Many of the teachers recognize these defects and do all that is possible to overcome them in their own experience and in their teaching. But there are some others who do not recognize them; who do not realize that because a man is a physiologist or a pathologist or an anatomist he is not necessarily a competent physician. Of course, the latter men are hopeless.

"Experience must make us face this fact, that very great devotion to science and scholarship is apt to be at the expense of practical skill. Let any one run over in his mind the most learned men in medicine that he has known—the men who have given themselves especially to scholarship or to scientific pursuits in medicine as distinguished from its practice—and see how few of them compare in the art of practice with other men of similar capacity—perhaps of less capacity—who have put the emphasis of their endeavors on the art of medicine.

"There is no reason why this should be regretted; there is no reason why there should be any inferiority complex about the practice of medicine. Men may properly have as much pride and pleasure in an intellectual technical vocation as in one primarily scientific. The technical pursuit may require just as interesting and just as high intellectual exercises as the scientific one. The intellectual quality of the work of an Elihu Thompson may be quite as brilliant and quite as exacting, to say nothing of the stimulus of its immediate usefulness, as that of a Herbert Spencer. There is a very creditable sort of brilliancy in being merely a great artist, particularly a great artist in a vocation demanding a scientific background and the assumption of the gravest responsibilities.

"'There is one glory of the sun, and another glory of the moon, and another glory of the stars; for one star differeth from another star in glory.' They differ in glory, but each has its own. What I would point out is that we should follow the scriptural wisdom of appreciating the glory of them all; that science has not all of it; and that in emphasizing it at the expense of the art we are cultivating a false sense of values in medicine and are failing to show, in evaluating ourselves and our function in the world, that important quality which, when applied to a consideration of the story of civilization at large, we call the quality of being historically minded."

The roentgenologist has found it particularly difficult during these formative years since Roentgen's discovery to keep at all times a true conception of the relative importance of science and art. It is not only that he has been compelled to absorb a tremendous amount of new knowledge with regard to the physics of radiant energy and

* Pusey, William Allen. The importance of being historically minded. *J. Am. M. Ass.*, Dec. 17, 1927, lxxxix, 2079–2082.

to familiarize himself with the operation of constantly changing apparatus, but in addition to this, and as the main reason for his existence, to apply the results obtained by his technical work to the diagnosis and treatment of disease. In other words, he has had to constantly remind himself that roentgenology is in itself both a science and an art and that his function is to correlate his knowledge and the results of his art in this special field with the practice of medicine as a whole, which in turn is both a science and an art. It is true in roentgenology just as in medicine in general that only a very few are qualified to do productive work in the field of scientific research. Such work is fundamental but its relative value must be determined by the results obtained when it is applied to the actual practice of medicine. "By their works ye shall know them" is a scriptural truth applicable not only to individuals but to the knowledge which science reveals.

We commend the entire article from which we have quoted above to the attention of all roentgenologists who aspire to rank as practitioners of medicine.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan Ave., Toledo, Ohio.
Twenty-ninth annual meeting, Kansas City, Mo., 1928. Date to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., June 11–15, 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. O. J. Shore, 2033 Park Ave.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. Everett Rowell, 200 West 59th St.
Meets monthly on third Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. James M. Flynn, 282 Alexander St.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Annual meeting, Galveston, Texas, 1928.

BRITISH EMPIRE

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London; W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.
Next meeting with the Gesellschaft deutscher Naturforscher und Aerzte will be in Hamburg, September, 1928.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.
Next meeting September 27, 1928, in Hamburg.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

LOCALIZATION OF FOREIGN BODIES IN THE EYE

To the Editor:

The note on the "Localization of Foreign Bodies in the Eye" in the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY for October, 1927, by Dr. Gordon E. Richards has interested me for the following reasons: I have been using this method since February, 1899, and have plates and films of about 200 cases in which the presence of a foreign body was shown either in the eye or in the region of the eye. The method originated from Dr. Karl Grossman, who at that time was an ophthalmologist in Liverpool, and a note describing the method is to be found in the *Liverpool Medico-Chirurgical Journal*, 1899, xix, 359, under the title of "The Localisation of Foreign Bodies in the Eye." Dr. Grossman illustrated the paper when read on April 13, 1899, by radiographs taken by myself.

On the first occasion I took the two radiographs on separate plates—changing these without moving the patient or the tube, and then made two exposures on the same plate. We also at one time used malleable wire to outline the forehead, eye and cheek, but later gave up doing so, and always used two plates rather than the double exposure on one plate. We also made plates with the patient looking to the nasal side and then to the temporal side.

The method is almost, but not quite, infallible as regards showing whether a foreign body is actually in the eye or not. It once "let me down," however, as the foreign body in this case had lodged in the wall of the orbit and had not actually penetrated, but hemorrhage had taken place into the eye as a result of the impact, and the eye was removed. If this method is combined with a direct posteroanterior view it is remarkable how accurate the information obtained is.

Fig. 1. Looking up. (Roentgenogram taken Feb. 5, 1899.)

Fig. 2. Looking down. (Same case as Fig. 1.) (Roentgenogram taken Feb. 5, 1899.)

Fig. 3. Looking up. (Roentgenogram taken May 18, 1899.)

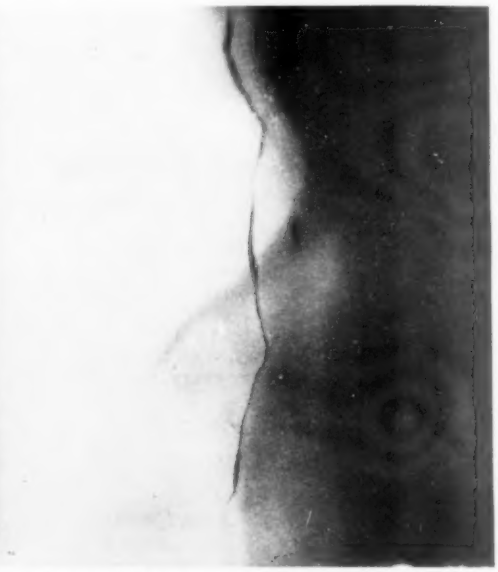

Fig. 4. Looking down. (Same case as Fig. 3.) (Roentgenogram taken May 18, 1899.)

The first attempt I made to show a foreign body in the eye was on October 21, 1897, and after various experimental plates of a skull with a shot fixed in different parts, I was able to say that the shot in this case had gone through the eye and was lying in the space behind. This x-ray was made with a ten-inch coil and a six-celled accumulator, on an ordinary photographic plate, and the exposure was 15 minutes. It was published in the *Archives of the Röntgen Ray* for February, 1898.

I send you with this two sets of radiographs. Figures 1 and 2 were taken on February 5, 1899, and this was the first time this method was used by us. The exposure by this time was two minutes for each radiograph, but on the double exposure plates it was one minute looking up and one minute looking down. Figures 3 and 4, taken on May 18, 1899, show the wire fixed over the forehead, eye and cheek. The same ten-inch coil energated by an accumulator was used for both these cases, but by this time we had advanced to a primitive type of mercury interrupter and a rather bigger and more reliable tube.

Fortunately I have kept all my notebooks, and most of my plates since the very beginning of things, and so can easily get these details and radiographs.

Yours sincerely,

C. Thurstan Holland.

Liverpool, England.

ADDITIONAL ITINERARIES FROM TEMPLE TOURS, INC.*

Tour No. 4

June 9	Sail from New York S.S. "Adriatic," $150 berth included.
18	Arrive Liverpool and Edinburgh.
19, 20, 21	Edinburgh. Motor excursion to Melrose and Abbotsford.
22, 23	Glasgow. Excursion to Ayr. Burns' Country. The Trossachs "Lady of the Lake" Country.
24, 25	The Lake District by coach and steamer.
26	By the Shakespeare Country, Stratford-on-Avon, Warwick, Kenilworth, and to London.
27, 28, 29, 30, July 1	London. Motor tour of the city. Motor excursion to Windsor, Eton and Hampton Court.
July 2	
3, 4, 5, 6, 7	Paris. Two motors drives around the city. Motor excursion to Malmaison and Versailles, chateaux, gardens and trianons. Motor excursion to Fontainebleau, chateau, forest and Barbizon.
8	To Frankfort.
9, 10, 11	Frankfort.
12	To Hamburg.
13, 14, 15	Hamburg. Motor tour of the city.
16	To Copenhagen.
17, 18	Copenhagen
19	To Oslo.
20, 21	Oslo.
22	To Stockholm.
23, 24, 25, 26, 27	Stockholm—Congress.
28	Sail on S.S. "Gripsholm"—$195 berth included.
Aug. 6	Arrive New York. Price: $980

Tour No. 3-A

July 7	Leave New York S.S. "Stavangerfjord," $165 berth included.
16	Arrive Bergen.
17	Bergen.
18	To Oslo by the scenic route.
19	Oslo.
20, 21	Rattvik.
22	To Stockholm.
23, 24, 25, 26, 27	Stockholm—Congress.
28	Sail by the S.S. "Gripsholm," $195 berth included.
Aug. 6	Arrive New York Price: $520

Extension for Tour No. 4 or No. 3-A

July 29	To Copenhagen.
30	Copenhagen. Motor tour.
31	To Berlin.
Aug. 1, 2, 3, 4	Berlin. Motor tour of city. Motor excursion to Potsdam.
5	To Prague.
6, 7	Prague. Motor tour.
8	To Vienna.
9, 10, 11	Vienna. Motor tour of the city. Motor excursion to Schonbrun.
12	To Munich.
13	Munich. City drive including Royal Estates of Nymphenburg.
14	Strassbourg.
15	To Paris.
16, 17	Paris.
18	Sail on S.S. "Caronia," $165 berth included.
27	Arrive New York. Price: $295 Extra.

* For full particulars and other itineraries address: Temple Tours Inc., Park Square Building, Boston, Mass.

ADDITIONAL ITINERARY FROM WALTER H. WOODS CO., BOSTON, MASS.

Sat., July 7	Sail from New York on the S. S. "Stavangerfjord" of the Norwegian American Line. Cabin accommodations at the value of $157.50 with tax provided.
Mon., July 16	Due to arrive Bergen in the morning.
Tues., July 17	By rail to Trengereid, thence by motor car across Kvamsskogen and via Aadland to Norheimsund, on the Hardangerfjord, one of the finest drives in this section of Norway.

Wed., July 18	By afternoon steamer on the Hardangerfjord to Ulvik.
Thur., July 19	By motor via Espeland's Lake, Granvin Lake, Voss and Opheim's Lake to Stalheim, probably the most beautiful spot in Norway.
Fri., July 20	By motor through the Naerodal to Gudvangen, thence by steamer through the magnificent Naerofjord and Sognefjord to Balholm, one of the finest resorts in Norway.
Sat., July 21	By afternoon steamer on the Sognefjord to Flaam thence by motor to Myrdal and leave at 11:00 P.M. in sleeping cars.
Sun., July 22	Arrive Oslo in the morning. A drive will be taken about the city. Leave in the evening in sleeping cars.
Mon., July 23	Arrive Stockholm in the morning. No hotel accommodations or sightseeing will be provided in Stockholm.
Tues., July 24 to Fri., July 27	In Stockholm attending the Second International Radiological Congress.
Fri., July 27	Leave Stockholm in the evening in sleeping cars.
Sat., July 28	Arrive Gothenburg in the morning and sail on the M. S. "Gripsholm" of the Swedish American Line. First Class accommodations at the value of $105.00 provided.
Mon., Aug. 6	Due New York.

The rate for this trip would be $540 per person based on the assumption that this would be a conducted party, stop at the finest hotels, and use Second Class rail wherever possible; otherwise First Class.

INSTRUCTION AND TRAINING IN MEDICAL RADIOLOGY THE MAIN SUBJECT OF THE SECOND INTERNATIONAL CONGRESS OF RADIOLOGY, STOCKHOLM, 1928

In the roentgen rays and in radiating matter medicine has found a means for diagnosis and therapy which has become indispensable for the healing art and which is growing in importance every day. Through research and systematic elaboration of gained experience roentgen diagnostics no less than radiotherapy have developed into extensive scientific specialities with their own working methods. In practical medicine radiology has in fact acquired a secure position as an independent discipline with its own institutions, led by specially trained radiologists. At the same time as medical radiology has developed, and greater and greater tasks have been allotted to it, it has become clear to the representatives of practical medicine no less than to the universities that a thorough special instruction and training in medical radiology is essential, not only to those intending to devote themselves entirely to radiology but also to specialists in different branches of medicine to whom radiology constitutes a necessary accessory science. The conviction that a survey of medical radiology should also be included in the general medical curriculum has more and more gained in force.

The organization of instruction, however, has not in all countries kept pace with the development of radiology in medicine, and the question of suitable forms of instruction and training in this science is everywhere on the program.

The Executive Committee of the Second International Congress of Radiology to be held in Stockholm July 23–27, 1928, has therefore resolved to take up *instruction and training in medical radiology* as the main subject of the Congress, medical radiology to include roentgen diagnostics and radiotherapy with its subdivisions, roentgen-, radium- and heliotherapy.

Primarily the Committee had decided to invite a few representatives only from some of the biggest radiological societies to put forth the experiences gained on this question and to make suggestions for the organization of the teaching and special training in medical radiology.

No sooner did it become known, however, that the question of instruction and training in radiology would be taken up at the Congress than a wish was expressed from different quarters that the Congress should take up this great problem as extensively and completely as possible. This question of instruction is evidently acute in all countries where radiology has reached a certain degree of development. The teaching, however, requires different forms of organization in different places according to, *inter alia*, the existing organization of medical instruction and hospital service, as well as to financial means.

We have therefore considered it advisable that the question of teaching should be taken up on a wider basis and that the Congress should collect instructive material concerning radiological teaching in the whole world. We have thought the best

possible result to be attained by inviting a lecturer on medical radiology, from each of those countries where organized instruction in medical radiology is known to exist, to give a short account of the historical development of the present organization of radiological teaching and training in the country to which he belongs, and to put forward views and suggestions for the organization of instruction and training in medical radiology for students as well as for those wishing to take up special branches of radiology.

All these papers will be published immediately after the Congress as a separate volume of the proceedings and will constitute an important source of information and stimulus for all those teachers and authorities responsible for the organization and further development of radiological teaching.

At a common session immediately after the inauguration of the Congress brief extracts—not exceeding fifteen minutes—of as many of these papers as time will permit, will be read. The Committee reserves the right to decide the order of these oral extracts and to limit the number.

By the arrangement suggested the question of radiological teaching is likely to be elucidated as extensively and thoroughly as possible. Time will not permit of any discussion after these papers. However, to also give others than those especially invited to speak on the subject, an opportunity of bringing forth their views on the organization of radiological teaching, written contributions to the discussion in English, French or German, not exceeding octavo page (400 words) will be accepted and published in the special volume of the proceedings, if received, at the latest, on the last day of the Congress.

GÖSTA FORSSELL
President.

AXEL RENANDER
Secretary-General.

DR. COOLIDGE AWARDED MEDAL

Dr. W. D. Coolidge, assistant director of the research laboratory of the General Electric Company, has been awarded the Hughes medal by the Royal Society for "distinguished work on X-rays and the development of highly efficient apparatus for their production."

The Hughes medal was first presented in 1913 to Dr. Alexander Graham Bell. Dr. Irving Langmuir, also of the General Electric research laboratory, received it in 1918.

AMERICAN COLLEGE OF RADIOLOGY

A convocation of the American College of Radiology was held during the week that the Radiological Society of North America met in New Orleans for its Thirteenth Annual Meeting. Honorary degrees of Fellowship in the College were conferred upon Prof. H. Behnken, PH.D., of Berlin; Jacques Forestier, Jr., M.D., of Aix-les-Bains, France; Prof. Franz M. Groedel, M.D., of Bad-Nauheim, Germany; Prof. Hermann Holthusen, M.D., of Hamburg, and A. Lacassagne, M.D., of Paris, all of whom were present.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

The Thirteenth Annual Meeting of the Radiological Society of North America was held at New Orleans, Louisiana, November 28 to December 2, inclusive.

The attendance was very good; the registration amounted to more than five hundred.

The entertainment furnished by the local committee was lavish, especial attention being paid to the visiting ladies, who are present in larger numbers at each successive meeting.

Among the foreign guests and contributors were Prof. H. Behnken, Prof. Dr. Franz M. Groedel, and Prof. Hermann Holthusen, of Germany, and Dr. J. Forestier, Jr., and Dr. A. Lacassagne, of France.

The scientific program was well balanced, particular attention being paid to practical dosimetry.

The scientific exhibit was divided into two groupings—institutional and individual displays. Each group was given a first, second, and third award. This competitive recognition stimulated a large display.

An innovation established several years

ago, consisting of clinics, was more popular than ever, and indicated the necessity for their continuance.

Edwin C. Ernst, M.D., was installed as President; M. J. Hubeny, M.D., was made President-elect; I. Seth Hirsch, M.D., First Vice-president; Frank S. Bissell, M.D., Second Vice-president, and William E. Costolow, M.D., Third Vice-president. Donald S. Childs, M.D., was elected a member of the Executive Committee.

A post-convention cruise to Cuba and points of interest in Central America was participated in by eighty-six members. The trip was most enjoyable, and emphasized the fact that social activities play an important part in the success of the organization.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DISEASES OF THE MOUTH. By Sterling V. Mead, D.D.S., Professor of Oral Surgery and Diseases of the Mouth, Georgetown Dental School; Professor of Diseases of the Mouth, Georgetown Medical School, Washington, D. C. Cloth. Price, $10.00. Pp. 578, with 274 illustrations in the text, and 29 full page color plates. St. Louis: C. V. Mosby Co., 1927.

In this book, the diagnosis, prognosis and treatment of diseases of the mouth are discussed in a systematic and comprehensive manner. The author is a dentist with a broad experience in oral surgery, and the chapters on diseases of the teeth and their investing structures are particularly well written. The value as well as the limitations of the roentgen examination, electric pulp test, transilluminating lamps, bacteriological examination and other diagnostic methods are well shown. There are chapters on diseases of the floor of the mouth and maxillary glands, diseases of the nerves and blood vessels and diseases of the lips, tongue and throat. There are also chapters on diseases of the maxillary bones, congenital cleft lips and palate, and on tumors and cysts. Appended to each chapter is a voluminous bibliography, and the numerous plates and illustrations add to the appearance and value of the book. Although written primarily for students of medicine and dentistry, the book is recommended to graduate dentists and physicians as a valuable work of reference.

L. M. CHRISTIE.

THE RADIOGRAPHIC DIAGNOSIS OF BILHARZIASIS. By G. O. Lotsy, Member of the "Institut D'Egypte," Cairo. Text in English, French and Arabic. Price, 19.-Sh. Pp. 30, with 11 photographic plates (43 roentgenograms, 1 photograph), and 11 plates with 42 schemes, and 2 schemes in the text. Cairo: H. Friedrich & Co., 1927.

This publication printed in English, French, and Arabic, is attractively written and illustrated. The small volume is introduced by an article on the parasitic, anatomical and clinical facts on the condition known as bilharziasis, an endemic disease of Egypt. Following this is the second part which is devoted to the "radiological part" of the subject. In this the infections of the bladder, lower parts of the ureters, and upper parts of ureters and kidneys are discussed separately with the presentation of case histories and the roentgenograms in each case. Following this is the differential diagnosis of bilharziasis. The condition is caused by the *Schistosomum haematobium*, the female of which after entrance into the system, finally forces her way against the blood stream to the venules in the bladder wall. There she lays large quantities of eggs which may bore their way through the bladder wall into the lumen of the latter or become calcified where they are. Secondary invasion of the ureters, resulting in papillomata, ulceration and fibrosis, with cicatrization, strictures and solidification follow. The ureter above the stricture dilates and there is a secondary destruction of the kidneys. There are the same calcifications in the walls of the ureters as are found in the bladder wall.

The quantity of calcified eggs in the tissues is the cause of the shadows of the bladder and ureteral walls on the plate. The cases must be differentiated roentgenologically from calculus in the urinary tract. The symptoms are similar to those of stone in the bladder with terminal hematuria and, in some instances, renal colic. The shadows are more clear and sharply defined and less apt to present ramifications than in bilharziasis. The fact that 60 per cent of the inhabitants of Egypt have the disease is of itself an important differential diagnostic point.

GEO. M. EDWARDS.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

ALBEE, FRED H. Spondylolisthesis. *J. Bone & Joint Surg.*, July, 1927, ix, 427–446.

Trauma is the primary cause of spondylolisthesis although there may be predisposing congenital factors. Approximately 200 cases have been reported to date. The only satisfactory treatment is the immobilizing spine operation. The author reports 8 cases in which most gratifying results have been obtained by this method. Two types of spondylolisthesis have been reported: (1) *Unilateral* in which the early symptoms of paralysis have been so pronounced as to render early diagnosis probable. Displacement is such that the spinal canal is narrowed, and the cauda equina compressed, with either complete or partial paralysis resulting. (2) *Bilateral*, with mild symptoms. There is practically always a space for the cauda equina. The change takes place slowly, and paralysis does not usually occur. Most cases are of this type.

Emphasis has been placed on the importance of taking roentgenograms in both the anterior and lateral views. The latter, though more difficult to secure are of great diagnostic value and by certain observers are considered absolutely essential to a correct diagnosis.

It should be frankly recognized that the diagnosis is not always easy and that as the condition is not unique it should be considered in all injuries of the lower spine. The appearance at first glance may suggest double congenital dislocation of the hip. However, this may be excluded by the case history, roentgenogram and by finding the trochanters on Nélaton's line. The general symptoms and sometimes the gait may simulate those of the lower lumbar Pott's disease but the shortening of the trunk, flexion of the thighs, peculiar lordosis, and attitude will serve to differentiate spondylolisthesis. Rickets increases rather than decreases the pelvic inclination, and other characteristic signs may usually be found. The roentgenogram is of course one of the most valuable aids to diagnosis.

ARMAND-DELILLE, P.-F., and VIBERT, JACQUES. Localization by lipiodol of an interlobular pleurisy masked by splenopneumonia. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 879–883.

Certain authors have already indicated the association of interlobular pleurisy with splenopneumonia; in many cases pleurisy is masked by the splenopneumonia. It has also been shown that splenopneumonia may be manifested by encysted pleurisy and may be considered as a pulmonary reaction due to local pleural inflammation. A case report is given in which lipiodol and roentgenograms were used in diagnosis.

A child two years old showed physical and functional indications of acute pneumonia of the upper left lung. Roentgenogram showed total opacity of the left thorax which appeared to be tuberculous splenopneumonia. However, no tubercle bacilli were found in washings obtained with the trocar. Later punctures showed an abundance of pneumococci instead, which indicated that the condition was encysted pleurisy caused by pneumococcus. Subsequent roentgenograms showed no change from the original picture. After another puncture and removal of serous exudate and pus, the resulting pocket was filled with lipiodol (15 c.c.). The roentgenogram taken immediately afterwards showed the lipiodol localized in the median anterior-inferior of the interlobe. This image was very clear in contrast to the less intense image of the splenopneumonia. This observation proves in a definite manner the association between pleural cyst and splenopneumonia. The method employed, lipiodol, permits observations of the area affected, without error, which is of considerable advantage in such cases.

BALLON, HARRY C. The value of lipiodol in the diagnosis and treatment of abscess of the lung. *Surg., Gynec. & Obst.*, 1927, xliv, 1–10.

A review of 94 cases of abscess of the lung is presented. A relatively high proportion (25 per cent) occurred following operations about the mouth and throat. Abscess of the lung in this series was found to be frequently associated with bronchiectasis. The relative infrequency of a demonstrable cavity with fluid level by ordinary roentgenoscopic examination in chronic abscess of the lung is noted. The use of lipiodol by the bronchoscopic method when combined with the definite routine examination is of undoubted value. No reactions from the use of this agent in this form of lung suppuration have been noted. Ordinary roentgenographic examination, *per se*, in many instances gave an ill-defined anatomical localization of the site of disease and even a false impression of the extent of the disease which clinical examination often failed to correct.

Shorter hospitalization and better results will be obtained when the surrounding parenchyma and bronchial architecture are completely defined; (particularly in relation to the left chest beside the heart shadow, to the lung area below the dome of the diaphragm, and in relation to ill-defined diaphragmatic shadows). Healthy tissue on the non-affected as well as on the affected side should be demonstrated before extensive operative procedure is commenced. The condition of the upper and lower respiratory tracts is of importance in obscure cases. Positive shadows demonstrated by injection of lipiodol, which were associated with signs and symptoms were proven to be trustworthy.

The material comprising this study was obtained from the records of the surgical service of the Royal Victoria Hospital, Montreal, Canada.

Bloodgood, Joseph C. Central sarcoma of bone. Is there a central fibroma or fibrosarcoma and how can it be differentiated from osteitis fibrosa? *J. Bone & Joint Surg.*, April, 1927, ix, 217–233.

One can feel quite safe in concluding that osteitis fibrosa is present in a case if the roentgenogram shows a definite bone shell, if the bone destruction is all within that shell and if there is no evidence (in the roentgenogram or on palpation) of any tumor formation outside the bone shell, provided also that at the exploratory incision there is found within the bone shell a mass of fibrous tissue difficult to distinguish from sarcoma in the gross and frozen sections. Conservative measures are in order. If there are many minute cysts, or one large cyst, this is evidence still more positive of a benign bone cyst (osteitis fibrosa). If the patient happens to be under twenty years of age the fact may be regarded as additional evidence that the lesion is benign. As more adults are studied roentgenographically for sprains and contusions, for slight pain or limp as well as for fracture, one may expect to see more and more frequently evidence of a single, healed or latent bone cyst. The predominant central lesions of bone are osteitis fibrosa and the giant cell tumor. Next in order of frequency comes the metastatic tumor. Development of chondroma, myxoma and sarcoma is not frequent. The multiple myeloma without evidence of other bone involvement is a rare disease. The time has come when all should learn to recognize osteitis fibrosa and the giant cell tumor in all their clinical, gross, microscopic and roentgenographic variations. Four illustrative cases are cited.

Bohmansson, G., and Runström, G. A case of intramedullary tumour of the spinal cord. *Acta radiol.*, 1926, vi, 211–216.

A description is given of a case occurring in a man aged twenty-seven. The diagnosis based on neurological examination was a tumor localized at the caudal end of the spinal cord. The roentgenogram showed no demonstrable changes in the thoracic or lumbar spine. A lumbar puncture was made between the 2d and 3d lumbar vertebrae and after removal of 5 c.c. of fluid there was injected 5 c.c. of lipiodol. After an hour a shadow about 2 cm. broad was seen between the lower edges of the 3d and 2d lumbar vertebrae. Above this region the shadow divided into two branches which continued up to the upper edge of the arch of the 12th thoracic vertebra. At this point the distance between the two parallel shadows was 2.5 mm. From this region they ran upward to the middle of the body of the 10th thoracic vertebra. The shape of the lipiodol shadow above the lower boundary of the 1st lumbar vertebra was caused by a compression of the subarachnoid space by the tumor growth, the lower limit of which was in the middle of the 1st lumbar vertebra and which extended 15 cm. upward.

At operation the tumor, intramedullary in type, was extirpated. The symptoms have disappeared for the most part. It is of the greatest importance for the attainment of best possible results that laminectomy should not be postponed too long.

Boorstein, Samuel W. Radiography during manipulation for closed reduction of congenital dislocation of hip. *J. Bone & Joint Surg.*, April, 1927, ix, 302–307.

Closed reduction of congenital hip, as well as changing of the plasters, can be helped materially by having roentgenograms taken before the application of plaster. The reduction and the application of the plaster should be done in the roentgenographic room on the roentgenographic table. The procedure helps one to decide the most advisable position to choose and indicates when it is safe to bring the hip down. It also obviates the necessity of removing and reapplying the plaster to correct a wrong or unsafe position.

The author has employed this procedure for some time and has found it of great help; and there has been no difficulty in taking the plaster outfits and the spica box to any roentgenographic laboratory and carrying out the reduction there. Three illustrative cases are cited.

BOORSTEIN, SAMUEL W. Osteochondritis of the spine. *J. Bone & Joint Surg.*, October, 1927, ix, 629–635.

Every case of deformity of the spine suggesting osteochondritis should be studied carefully to establish a definite symptomatology of this entity. Vertebral osteochondritis is characterized by deformity of the spine in the form of a knuckle or a generalized kyphosis or scoliosis associated with very slight or entire absence of pain. The roentgenograms usually show only one vertebra affected, which assumes a cuneiform shape. There is absolutely no involvement of the discs above and below the diseased vertebra. The cartilage usually is thicker and there is often new formation of this tissue.

The etiology of the condition is unknown as in the cases of Legg-Calvé and Osgood-Schlatter's diseases. The treatment is immobilization in plaster-of-Paris jacket or a brace. Source of infection should be sought.

Two cases are described, one in a boy aged seventeen, the other in a girl aged two.

BRAASCH, WILLIAM F., and HAGER, BENJAMIN H. Ureteropyelography. *Surg., Gynec. & Obst.*, 1927, xliv, 433–454.

In the interpretation of shadows in roentgenograms of the urinary tract the following are the most common causes of confusion: (1) localized areas of tissue calcification, such as calcified lymph nodes, and irregular mottled areas occurring in the renal parenchyma as a result of calcium deposition in renal tuberculosis, in hypernephroma, and in pyogenic abscesses which have undergone resolution calcification; (2) gallstones; (3) multiple shadows, one or more of which require identification and localization; and (4) the shadows of multiple stones in the kidney not necessarily having similar characteristics, so that while the shadow of one stone may be typical of renal lithiasis the other may be suggestive of an extrarenal shadow. Because of the similarity of various shadows seen in the roentgenogram their exact nature can be determined only by the pyelo-ureterogram.

If the films are clear, the outline of the kidney can often be seen, and a fair idea of the position and size of organs is obtained. Occasionally with external tumors or cysts of the kidney the relationship of the soft shadow cast by the tumor to that of the renal outline can be demonstrated. With horseshoe or fused kidney the proximity of the renal shadow to the vertebrae as well as the connecting isthmus is occasionally shown. Too much reliance should not be placed on the renal shadow as it is occasionally demonstrated in the roentgenogram when a kidney has been removed. It is possible that therefore the shadow is cast by the renal sulcus; at best, shadows of abnormalities in the position and of the size of the kidney as seen in the roentgenogram are merely suggestive and must be corroborated by other data.

A fairly detailed discussion is given of the various aspects of interpretation of the ureteropyelogram for which the original must be consulted. The subject is discussed under the following headings; obstructive dilatation of the pelvis; dilatation of the ureter; strictures of the ureter; renal neoplasm; polycystic kidney; solitary cyst; extrarenal tumor; source of error in the interpretation of the pyelogram; lithiasis; cortical stone; anomalies; duplication of the renal pelvis, duplication of the ureter, fused kidneys; congenital increase or decrease in size of pelvis; renal torsion and ectopic or pelvic kidney.

BUCHMAN, JOSEPH. Osteochondritis of the vertebral body. *J. Bone & Joint Surg.*, January, 1927, ix, 55–56.

Vertebral osteochondritis is an entity distinct from vertebral epiphysitis though fundamentally they are similar processes with similar characteristics occurring at different growth periods. Vertebral osteochondritis sets in during the first few years of life and is characterized by moderate or very slight pain, fatigue, night cries, muscle spasm, tenderness, deformity in the form of a knuckle or a generalized kyphosis or scoliosis. Roentgenographically it is characterized by an irregularity of the vertebral outlines, flattening, and wedging of the vertebrae to be followed by the stage of restitution when the vertebral outlines appear dense and sclerosed. Deformity of the vertebral bodies is the final result. The intervertebral spaces are widened in proportion to the thinning of the vertebral bodies.

The etiology of the disease is unknown. From theoretical and analogous clinical observations and pathological studies it seems that an imbalance between the static demand and static capacity is a likely cause of this disturbance. The static imbalance is most likely to occur during the first and second periods of rapid growth—in spine cases from birth to six years of age and about eleven to sixteen years of age. All of the treated cases have done well under recumbency and plaster-of-Paris jacket treatment; but they all show a remaining deformity which does not interfere with activity. Two cases are described.

Carlsten, D. B. Lipiodol injection in the ducts of the salivary glands. *Acta radiol.*, 1926, vi, 221–223.

A report is given of a case occurring in a woman aged twenty-nine suffering from a bilateral ectasia of the parotid ducts. The symptoms suggested the possibility of concretions within the ducts and a roentgen examination yielded a negative result. Lipiodol was then injected into both parotid ducts and the roentgenogram showed the dilated ducts throughout their whole extent including almost their finest branches. About 5 c.c. of lipiodol could be introduced into each of the glands. The roentgenogram disclosed no abnormally large cavities associated with the glands or their ducts.

The cause of the pathological condition was not determined in this instance.

Carman, Russell D. Further observations on the roentgenologic diagnosis of gastrojejunal ulcer. *Acta radiol.*, 1926, vi, 224–229.

Two hundred cases of gastrojejunal ulcer have been examined roentgenologically and operated on at the Mayo Clinic from 1915 to 1926. In 97 cases the original gastroenterostomy had been performed at the Clinic. These constitute 2.3 per cent of the total number of cases in which gastroenterostomy was performed at the Clinic during the ten-year period. Ninety-three per cent of the cases were in men. Duodenal ulcer was the original lesion in 89 per cent and gastric ulcer in 4.5 per cent. In 96 per cent the primary operation was a posterior gastroenterostmy and in 4 per cent an anterior gastroenterostomy. The interval between the primary operation and the discovery of the gastrojejunal ulcer varied from six weeks to twenty-one years, but more than half the ulcers were found within one to four years.

Exact roentgenologic diagnosis of gastrojejunal ulcer is difficult but in about 80 per cent of the cases the examiner was able either to make the diagnosis or to report definitely abnormal findings. The manifestations of ulcer fall into two groups, namely those which denote malfunction of the gastroenterostomy and those which are characteristic of ulcer. Of the indirect signs a relative enlargement of the stomach and six-hour retention are perhaps the two most important ones. Direct signs include the niche, deformity and narrowing of the stoma, and irregular narrowing of the efferent jejunal loop. Gastrocolic fistulas resulting from perforated ulcer are sometimes apparent at examination with the opaque meal, but they are best demonstrated by the enema.

Case, James T. Jejuno-ileal diverticula. *Acta radiol.*, 1926, vi, 230–240.

Eight additional cases of diverticula of the duodenum and of the colon are reported, the diagnosis being made from the roentgen examination. Many of these cases of small intestine diverticula exhibit no symptoms, but about one-fourth of them caused symptoms bringing the patient to operation or death, usually on account of intestinal obstruction. The chief subjective symptoms are: mild and prolonged indigestion; bilious attacks, more accurately described as autointoxication; loss of appetite, nausea and sometimes vomiting; coated tongue; intermittent abdominal distention; mild but persisting indefinite pain; muddy complexion and general debility; constipation sometimes alternating with diarrhea. Acute intestinal obstruction sometimes supervenes, through inflammatory changes in the sac, peridiverticular peritonitis and adhesions. Enteroliths sometimes form or lodge within the diverticula.

The roentgen signs are: an avoid area which in the upright position shows a fluid level, with gas above and opaque material below. Each such area represents a diverticulum; only the larger ones are detectable. Differential diagnosis must be made between peritoneal tuberculosis with multiple small intestine obstruction; diverticula of stomach or of duodenum, especially of the duodeno-jejunal angle and Meckel's diverticulum. Duodenal ulcer is a rather frequent accompaniment of jejuno-ileal sacculations. Many cases show diverticula elsewhere in the digestive tract and also in the urinary bladder.

Claessen, G. Some notes on radiography in the demonstration of syringomyelitic arthropathy. *Acta radiol.*, 1926, vi, 296–302.

Two cases are reported of syringomyelitic arthropathy (in the shoulder joint and the wrist respectively) involving extensive destruction of the bones. The first case occurred in a woman aged forty-seven. There was a spontaneous fracture of the humerus and the latter was found to be largely destroyed. The glenoid cavity and the neck of the scapula also were completely gone. The neurologic examination showed the abnormalities of sensation characteristic of syringomyelia. The second case occurred in a seaman aged forty-seven who had for some time been suffering from a fistula on the back of his hand. Roentgenographic examination revealed a state of enormous destruction in the carpus, metacarpus, ulna and radius, with volar subluxation of the hand. Analgesia

was present in the hand and in the forearm. In both cases the symptoms appeared suddenly after trauma.

Attention is directed to the remarkable disproportion in these cases between the slight and brief subjective symptoms and the extensive destruction of the bones. Brief descriptions are given of the atrophic and hypertrophic types of the anatomical changes occurring. In differential diagnosis the following diseases must be considered: arthritis deformans, tuberculosis, sarcoma, leprosy and tabes dorsalis.

Cole, Lewis G. Etiology of gastric ulcer. *Acta radiol.*, 1926, vi, 303–314.

An intensive study of ulcers and gastric motor phenomena disclosed an interesting relationship between the sulcus angularis and the most frequent site of gastric ulcers. The sulcus angularis is a mucosal apron that hangs down or projects about one-third the way across the lumen of the stomach between the corpus and the pyloric canal. The sulcus is a functional contraction rather than an organic fold and therefore it is not easily studied surgically or at necropsy. It may be observed roentgenoscopically or by single films, but it is best studied by means of serial roentgenograms with the patient in the erect posture after the administration of barium suspended in a fluid menstruum rather than in a pap. This apron-like fold of mucosa is attached to the lesser curvature at the point where Aschoff says the blood supply is already taxed to its limit. About 4 sq. cm. of mucosa are supplied with blood by about 1 sq. cm. of gastric wall at this most anemic area. The cramping of the blood vessels regarded by Bergmann as an important factor in his spasmogenic theory of gastric ulcer, is a constant factor in this long apron-like fold whether or not the stomach is in a state of spasm.

There are four types of gastric spasm: (1) hyperperistalsis caused by obstruction at or just beyond the pyloric sphinceter; (2) broad deep gastric sulci occurring at irregular intervals not associated with the gastric cycle; (3) pylorospasm, and (4) spasm evidenced by a narrow single sulcus on the greater curvature, sometimes less marked on the lesser curvature, resembling deep peristaltic sulcus but not progressing pyloruswards with the peristaltic waves. All the peristaltic sulci relax during diastole and move from one area to another during each gastric cycle, except the sulcus angularis which "marks time" during systole, and does not relax during diastole. Consequently the blood vessels in this region of the sulcus are kinked during diastole as well as during systole.

The concentrated digestive secretions of the peptic glands follow the rugae from the fundus and impinge on the proximal surface of the apron-like fold which in turn deflects this secretion into the chyme in the sinus of Forssell. The proximal surface of the fold is thereby subjected to the strongest gastric secretions before they are diluted by chyme. Trauma, particularly the trauma associated with vomiting is the greatest on the proximal surface of this mucosal fold since it is pressed against the pyloric canal which is closed during vomiting. The mechanical trauma of the gastroscope, the stomach tube and particularly the string as employed in the string test for the diagnosis of gastric ulcer should be avoided. Infection may be a factor in the etiology of gastric ulcer, but infection alone causes but a temporary ulcer which heals rapidly. The sulcus angularis is particularly susceptible to injurious factors because of the following disadvantages: anemic areas, spasm, trauma and infection. Consequently as a factor in the etiology and pathogenesis of gastric ulcer this apron-like fold is worthy of serious consideration.

Collin, Edv. A method of radiographing the mastoid process. *Acta radiol.*, 1926, vi, 315–321.

The author's method is a modification of the tangential method of Passow combined with an oblique projection. Use is made of the Forssell screening stand which has the advantage of causing less discomfort to the patient. The position of the head is fixed by a brass centering device (for details the original must be consulted).

At the Finsen Institute it is customary to take six roentgenograms in all. First, two sets in the tangential projection and then one from each side in the oblique projection. For this method of examination to be successful to the full extent of its possibilities, it is absolutely indispensable for the roentgenologist to give himself ample time both to the making and to the reading of the roentgenograms, the interpretation of which requires careful and thorough study. The changes revealed by the roentgenograms may be so apparent as to preclude all doubts as to their interpretation. On the other hand, they may be so faintly shown that nothing very definite can be deduced even after a most careful inspection.

Castex, Mariano R., Romano, Nicolas and Gonzalez, Hernan. Roentgenologic examination of pyopneumo-cyst below the diaphragm with lipiodol injection. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 222–226.

The exact information furnished by the use

of lipiodol in the study of subphrenic gaseous abscesses is well illustrated in the case reported here. The clinical diagnosis of the patient reported here was that of suppurative gaseous cyst of the liver. Twenty c.c. of yellow pus was removed by puncture, and 20 c.c. of lipiodol substituted. In this way it was possible to show clearly the exact position, contour and relation of the cyst to internal organs, which is of particular importance to the surgeon. The injection of lipiodol in such cases as this is simple, inoffensive and gives information of both practical and scientific value.

CASTEX, MARIANO; CARELLI, HUMBERTO and GONZALEZ, HERNAN. Lipiodol in the roentgenographic examination of the pericardium. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 217–222.

Lipiodol can be used to obtain roentgenograms of the pericardium with perfect safety, even when used in considerable doses, without any inconvenience and without great technical difficulties. It has been used with success in the treatment of hemorrhagic tuberculous pericarditis. Its use can then be both diagnostic and therapeutic. The present case is that of a young man twenty-four years old who was suffering from pericarditis with effusion. Three hundred c.c. of serohemorrhagic liquid was withdrawn by intercostal puncture; this liquid showed the presence of the tubercle bacillus. Roentgenograms showed considerable thickening of the parietal layers of the pericardium. In a roentgenogram taken in the reclining position, adhesions of the two pericardial layers were indicated. Later, after extracting 100 c.c. of liquid, 20 c.c. of lipiodol was injected; the outlines of the contour of the pericardium were brought out very clearly and it was shown that there were no adhesions. Injections of lipiodol at ten to twelve day intervals did not affect the progress of the affection, which followed the usual course. The results obtained in this case were such as to encourage the use of lipiodol in the examination of the pericardium by this method.

EIKENBARY, C. F. A second report on a hitherto undescribed dystrophy, probably of luetic origin, affecting particularly, the joints of the lower extremities. *J. Bone & Joint Surg.*, July, 1927, ix, 387–403.

The author reported in 1914 on a condition affecting the joints of the lower extremities in 3 members of a family of 7 children. This hitherto undescribed dystrophy in these children has been studied further, and the author believes that it is probably due to syphilis. This conclusion is based on the early history of the three children; the appearance of the tongue and lips in all the 3 children; the pathological report following biopsy on the knee in one case; Wassermann tests made in 1927; exclusion of tabes and syringomyelia; the failure to find any similar condition described in the literature as occurring in congenital syphilis. The roentgenograms of the joints of the lower extremities are given, and these are believed to support the author's conclusion.

Dr. F. H. Baetjer, Baltimore, commenting on these roentgenograms states: "It seems to me that we are unquestionably dealing with a neuropathic lesion. If these x-rays were of patients around the age of forty-five or more, one would unhesitatingly say that we were dealing with Charcot joints or syringomyelia. It has been my experience, however, that syringomyelia as a rule attacks the joints above the waist and rarely the knees and ankles, whereas the tertiary syphilitic lesions may hit any joint, but particularly the lower ones. I have never seen a case of Charcot joint in congenital lues, and I have not been able to find any reference to such a condition. The syphilographers at Johns Hopkins tell me that they have never seen such a condition, but, notwithstanding this, it seems to me that with three children involved and with these neuropathic joints, even if the Wassermanns continued to be persistently negative, I would still be forced to believe that they were syphilitic in origin and would have to characterize them as Charcot joints."

EISENDRATH, DANIEL N. Nephrolithiasis—a clinical study of seventy-one cases. *Surg., Gynec. & Obst.*, 1927, xliv, 317–327.

Recurrence of nephrolithiasis may be due to a number of causes. In a certain percentage of the cases some of the calculi are overlooked at operation. In a larger percentage of the cases the calculi are formed anew as a result of (1) persistence of infection; (2) persistence of inflammatory dilatation or of thickening of the renal pelvis; (3) mechanical obstruction or muscular atony distal to the kidney. In some of the cases recurrences may not appear for ten years or more.

A thorough urological study must always supplement a good clinical history, and general physical examination is quite necessary for the diagnosis. Routine pyelography permits the demonstration of renal calculi in about 90 per cent of cases before operation. When a shadow suspected to be that of a renal calculus is "included" in that of the pyelogram, the diagnosis of its intrarenal nature is far more

certain than when an opaque catheter alone is employed.

Before resorting to operation it is important to determine the condition of each kidney. The indications for operation are briefly discussed together with the technique and postoperative complications.

FIESSINGER, NOEL, and OLIVIER, H.-R. Gangrenous abscess of the lung examined by injection of heavy and light lipiodol. Healing by artificial pneumothorax. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 693–694.

The use of lipiodol in this case made correct diagnosis possible, differentiating between intrapulmonary gangrenous abscess and interlobular pleurisy. The symptoms at first suggested pleurisy, but roentgenograms after injection of heavy and light lipiodol showed definite evidences of a large abscess instead. The sputum showed no tubercle bacilli, but large numbers of anaerobic bacilli were found. After injection of 4 c.c. of heavy and light lipiodol the roentgenogram showed the heavy oil deposited round the edge of the cavity, outlining the irregularities and unevenness. A large round mass was disclosed by the light oil; this information together with the irregularities shown by the heavy oil, the wide band of tissue, etc. confirmed the existence of an abscess. Artificial pneumothorax was resorted to instead of surgical interference, with favorable results, the patient being entirely cured after about two months' treatment. The value of the lipiodol-roentgenogram examination was indispensable in the diagnosis of this case.

FORESTIER, JACQUES. Roentgenologic examination of the lungs with lipiodol: (1) in the course of abscess of the lung; (2) after extrapleural thoracoplasty. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 712–716.

The author gives a review of the methods used in the United States and Canada in the use of lipiodol in lung examinations. One case examined by the author in Canada is given in detail. In this case, therapeutic pneumothrax was impossible because of adhesions due to tuberculosis. The patient had not derived relief from treatment in many hospitals. By the use of lipiodol and roentgenograms an explanation was obtained. It was shown that in the inferior lobe of the left lung there were numerous bronchiectases of the tubes. The upper region was almost closed by adhesions, which accounts for the absence of tubercle bacilli in the sputum for two years. The condition was not typical of tuberculosis but the pulmonary lesions were complicated by dilatations of the bronchioles, without doubt due to secondary infection. This type of case should not be treated as tuberculosis, but as bronchiectasis, the bronchial cavity being the seat of persistent suppuration.

GRAHAM, EVARTS A. The present status of cholecystography and remarks on the mechanism of emptying the gall-bladder. *Surg., Gynec. & Obst.*, 1927, xliv, 153–162.

Summarizing all the reports in the literature, there were 446 cases in which gall-bladders diagnosed as pathological by cholecystography were examined at operation and only 10 were found not to corroborate the roentgen-ray diagnosis. This gives a percentage of correctness of 97.8. The author still prefers the intravenous method of administering the dye and adheres rather closely to the prescribed technique.

Thus far experiments have been made on 43 different substances of which 12 have been found able to render the gall-bladder visible. However, all of these compounds have in varying degrees some toxic properties. The ideal agent is still to be discovered. Up to the present the one which seems most satisfactory from the standpoint of toxicity is phenoltetraiodophthalein. This compound can also be used simultaneously for a test of hepatic function. The author has employed it for cholecystography almost exclusively during the past six months and in a total of 503 cases there has not been a single instance of severe general reaction.

Since the advent of cholecystography new light has been shed on the mechanism of gall-bladder emptying. It became quite clear that the mechanism of emptying must be different from that of the urinary bladder and of the intestine. A part of the emptying of the gall-bladder seems to be due to increased abdominal pressure. The observations up to the present show that it is not necessary to consider active intrinsic contractions of the gall-bladder wall as essential in the emptying process. These observations are, however, opposed to the current conception that certain substances as, for example, magnesium sulphate and pituitrin empty the gall-bladder by causing a contraction of its walls. But there is no satisfactory evidence that these substances do cause an emptying of the gall-bladder, although they may have a minor part in making a shadow of the organ disappear. Anatomical considerations indicate that the supposedly specific effect of pituitrin and of magnesium sulphate in emptying the gall-bladder depends chiefly, if not entirely, upon the production of duodenal

peristalsis and that much, if not all, of the importance formerly ascribed to the sphincter of Oddi had properly be ascribed merely to variations in tonus of the ordinary duodenal musculature.

HERNDON, RICHARD F. Back injuries in industrial employees. *J. Bone & Joint. Surg.*, April, 1927, ix, 234–269.

A study was made of 941 consecutive cases of back injuries in industrial employees. Sprain occurred in 498 cases. The most frequent site was the lumbosacral region and in about 11 per cent the condition seemed to be sufficiently localized to warrant the term sacroiliac sprain. The next most frequent site was the mid and upper lumbar region. In about half the cases the lesion appeared to be unilateral. In the other half the lesion was located centrally. The average period of disability in 310 cases where it was known was five weeks.

Fracture of the vertebral processes occurred in 41 cases. In 36 cases the fracture involved one or more of the transverse processes. In about half of these the fracture was due to abnormal muscular pull. The processes of the third lumbar vertebra were the most frequently involved.

Fracture of the vertebral bodies occurred in 30 cases. Many of these followed what seemed to be slight accidents and were surprisingly devoid of symptoms. Two-thirds gave no history or showed no evidence of cord involvement

HERNDON, RICHARD F. Three cases of tabetic Charcot's spine. *J. Bone & Joint Surg.*, October, 1927, ix, 605–612.

The first case was an old advanced process. The roentgenogram showed involvement and destruction of the second and third lumbar vertebrae with compression, rotation and scoliosis. The intervertebral spaces were obliterated. There were large purposeful osteophytes bridging the affected vertebrae so as to support the involved portion of the spine. These bridges were fairly well smoothed off and showed mature osseous content. After an interval of four and a half years, the roentgenogram showed some progress in the original lesion. In addition there had occurred extensive destruction of the fifth lumbar vertebra which had practically disappeared except for its transverse and spinous processes. The upper portion of the sacrum was also eroded.

The second case showed roentgenographically a relatively early process involving chiefly the first lumbar vertebra. There was destruction of the space below it with tilting and rotation. There was not much bony destruction but osteophytes had already produced ankylosis. Elsewhere there were found the smaller osteophytes of chronic arthritis. In the lateral picture the interspaces above and below the first lumbar vertebra were obliterated so that the bodies of the twelfth dorsal and first and second lumbar vertebrae appeared as a solid cylinder of bone.

The third case showed a typical neuropathic arthropathy involving chiefly the fourth lumbar vertebra which was almost completely destroyed. There were enormous proliferating osteophytes on either side. Each of these showed a rounded hole, apparently the opening for the spinal nerve.

Charcot's spine like similar manifestations in other joints usually develops rather quickly and painlessly. The diagnosis rests upon the typical manifestations occurring in the presence of the usual evidence of tabes. One of the most characteristic features is the disproportion between the severity of the process disclosed roentgenographically and the slight discomfort and disability complained of by the patient.

HINMAN, FRANK. Pyelovenous backflow at the time of pyelography. *Surg., Gynec. & Obst.*, 1927, xliv, 592–600.

An anatomical study is presented from which it is concluded that the pyelovenous backflow frequently observed in pyelography is a real occurrence and that tubular backflow for a short distance into the papillary ducts also may take place. In the case of pyelovenous backflow radiation into the cortex first appears as a cone or funnel deformity from the base of the pyramids, and if back pressure is sufficient may later show the arch from filled anastomotic venous arches. Radiation into the cortex then appears along the interlobular veins, a picture that never occurs with tubular backflow in which there is a short brush-like radiation from the tip of the papilla into the medulla for a short distance. Such pyelovenous and papillary backflow when unrecognized may lead to errors in interpretation of pyelograms.

This is illustrated in a case occurring in a child aged fifteen months in whom a diagnosis of tumor of the kidney was made because of indications in the pyelogram in addition to the mass felt on palpation. An exploratory operation disclosed a normal kidney and a piece of kidney tissue excised as near as possible to the point where the filling defect was shown was found negative microscopically. (The palpated mass was enlarged liver.)

LAIGNEL-LAVASTINE and VALENCE. A new case of Recklinghausen's disease with osseous

dystrophy. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, l, 273–276.

This is a report of a congenital osseous malformation in a man forty-four years old in which a diagnosis of Recklinghausen's disease was made. The lesions were in the parieto-occipital region, but there were no noticeable effects on the brain. Neurological examination did not show any effect on the nerves. A roentgenogram of the skull in profile showed a distinct space in the occipito-parieto-temporal region which confirmed the diagnosis. Another roentgenogram taken from the oblique posterior right gave a very clear picture of the abnormal bone structure.

LAWSON, JOHN D. The use of iodized oil in the demonstration of empyema cavities and fistulous tracts. *Surg., Gynec. & Obst.*, 1927, xliv, 11–14.

The value of iodized oil as a diagnostic method makes itself apparent when the surgeon requests information as to size, extent and shape of the empyema cavity. This can be very definitely determined by the injection aseptically of iodized oil into the fistulous tract having its opening formed by the original drainage tube. Moreover, tuberculous sinuses can be injected in the same manner and their connection with bone lesions proved or disproved. Postoperative abdominal fistulae may be localized to a very accurate degree and the exact point of the connection or lack of connection with the gastrointestinal tract may be discovered by this means. In fact, any type of sinus which has an opening to the exterior may be investigated in this manner and much information obtained which could not be acquired in any other way. Beck's paste, various types of barium and bismuth suspensions have been employed but they possess marked disadvantages. Various iodide and bromide solutions are too irritating on the tissues. Iodized oil, on the other hand, appears to be the most satisfactory.

LEGG, ARTHUR T. The end results of coxa plana. *J. Bone & Joint Surg.*, January, 1927, ix, 26–36.

A study was made of the end results in 40 cases whose duration has been ten years or longer. The author concludes that the final results seen in coxa plana show a distinct difference in the two types of cases. The *musbroom type* shows no marked atrophy or fragmentation of the epiphyseal bone centers. The epiphysis may migrate to the great trochanter in some cases; in other cases it migrates very little. Abduction and at times rotation are limited, when the epiphysis shows marked migration, but if there is very little migration, motion at the hip may be normal in adult life. There is less shortening in this type.

The *cap type* exhibits (1) marked variation in radiability in the epiphyseal bone center and neck; (2) fragmentation of the epiphyseal bone center, and (3) marked shortening and rounding off of the upper angle of the neck. The epiphysis in some cases seems to be obliterated. The ultimate limitation of motion and shortening of the leg are generally considerable. It is believed therefore that early in the course of coxa plana one may prognosticate with much assurance what the final limitation of motion and amount of shortening is likely to be in any given case.

LEWIN, PHILIP. Osteochondritis deformans juvenilis of the shoulder joint. *J. Bone & Joint Surg.*, July, 1927, ix, 456–457.

A report is given on a girl aged six under the author's care at various times since she was eight weeks old. The child was born at full term and the labor was normal. When first seen in 1920 she presented a typical case of birth palsy involving the entire right arm with extreme ulnar deflection of the hand. Roentgenograms revealed no demonstrable bone of joint pathology. Treatment was instituted in the usual manner by means of a Sever type or splint holding the shoulder in abduction, the elbow flexed, the entire arm in external rotation, the forearm in supination and the hand in dorsiflexion. Passive movements were instituted at the outset, and when the child was older active movements were supplemented. In 1922 the roentgenograms revealed no pathology. A very good functional result was obtained. Roentgenograms made in 1926 revealed a condition the pathogenesis of which is believed by the author to have been due to manipulation during the course of treatment, that is forcible stretching and movements that were necessary during the physiotherapy and medical gymnastics demanded by the treatment. The last roentgenograms showed flattening of the medial and inferior surfaces of the head of the right humerus with fragmentation and changes in the glenoid. There was a well-developed cervical rib on the right side and the right scapula was elevated. The head of the right humerus was articulating with the glenoid cavity.

MCBRIDE, EARL D. Congenital deficiency of the clavicle (hereditary cleidocranial dysostosis). *J. Bone & Joint Surg.*, July, 1927, ix, 545–552.

Two cases are reported in boys. The first was five years old, an active child of normal size and mentally bright. There was no evidence of epiphysitis or postural deformity. The most noticeable feature was the prominent forehead. There were six bosses on the head, two each on the frontal, parietal and occipital regions. A vertical furrow separated the frontal bosses, and the fontanelle was closed. Both clavicles were present but there was false motion in the middle portion of each. The fragments of the clavicles could be brought end to end but they slid about one another in all directions. Both shoulders could be brought forward so as to touch their medial borders. The roentgenogram showed full length clavicles on each side with a separation in the middle of each. The appearance was that of non-union of a fracture. The ununited ends were rounded and separated but not overlapped. The acromial end of each clavicle was apparently not quite fully developed. There was also roentgenographic evidence of slight rudimentary ribs extending from the seventh cervical vertebra. The roentgenogram of the head showed normal bone texture.

The second patient was nine years old. He presented essentially the same features as the first case and in addition had a double coxa vara. The roentgenogram showed each femoral neck and head to be well formed. Roentgenograms of the shoulder showed complete absence of both clavicles with the exception of a slight rudiment of the outer end of the left. Other structures were normal.

These cases are of medicolegal interest because of their resemblance in some respects to fracture of the clavicle.

Mayer, Ch. The roentgen ray and radium in investigations concerning poisoning. *Compt. rend. Soc. de biol.*, 1926, xciv, 1208–1209.

Roentgenologic examination of cases of poisoning may be used to advantage in legal medicine and in biological investigations. It may be used in searching for substances of high atomic weight, such as As, Br, Ag, I, Hg, Pb, etc. The task of the investigator may be simplified and this test may be of further value in substantiating chemical analyses. In some cases it is almost impossible for the chemist to obtain accurate results; in such cases the roentgenologic method would be of tremendous advantage. This method can be used to determine whether or not poison entered the body before or after death by its position with relation to surrounding tissues and organs. The author in some experiments demonstrated the feasibility of this method and obtained very clear-cut results with the above named substances. This method can also be used in examining food, such as preserves, flour, bread, etc.

Melicow, M. M., and Gile, Harold H. Radiographic simulation of renal calculi by papillomata of the skin. *Surg., Gynec. & Obst.*, 1927, xliv, 230–231.

Two cases are reported where papillomata of the skin of the back cast shadows on roentgen-ray plates which resembled those of renal calculi. The pathological report on the incised tumors was papilloma of the skin in the first case and fibroma of the skin in the second. Chemical analyses were made of the excised tumors. In the first case there was a slight trace of phosphorus, calcium and magnesium, while in the second there was no trace of calcium, phosphorus or magnesium.

The significant factors governing the density of the shadows caused by these tumors seems to be their relative nearness to the film and the amount of air which surrounds them. The two cases cited illustrate the importance of looking for and noting the presence of any skin growths when referring a patient for roentgenography.

Morton, Dudley J. Metatarsus atavicus: The identification of a distinctive type of foot disorder. *J. Bone & Joint Surg.*, July, 1927, ix, 531–544.

A painful disorder of the anterior portion of the foot for which the term metatarsus atavicus seems to be most applicable, presents two characteristic signs which warrant its recognition as a definite clinical entity. The first is a morphological sign manifested in the unusual shortness of the first metatarsal bone as compared with the second. The other sign is the clinical symptom of tenderness elicited by deep pressure on the sole of the foot in the region of the second metatarsocuneiform joint.

Since all the clinical manifestations of this disorder result from conditions created by the more distal position of the head of the second metatarsal bone as compared with that of the first, roentgen examination furnishes the most positive means of diagnosis. Typically, the basal joints of the first and second toes of the human foot are about even with each other, but in this instance, the head of the second metatarsal bone is definitely in advance of that of the first. Its degree of advance differs in the feet of various individuals from a normal, almost equidistant arrangement to conspicuous disparities. Associated with the more extended position of the second metatarsal bone there is an increase in the transverse diameter of its shaft and in the thickness of its dense cortical walls. It presents a marked contrast to the lat-

eral slenderness of the three outer metatarsal bones, and may even exceed the breadth of the first metatarsal. In the vertical (dorsoplantar) diameter, a similar hypertrophy is not to be observed, and usually the lateral roentgenographic view of the foot gives poor definition of the disproportionate development of the metatarsal bones.

Identification of this type of disorder facilitates the recognition and treatment of what appears to be a very large group of painful foot cases. Although in its range of subjective symptoms the present condition simulates other metatarsal disorders, the means of diagnosis and the elements of treatment are distinctive and specific. The early part of the treatment consists of eliminating the effects of chronic traumatic irritation. When this has been accomplished, conditions have been restored which characterized the efficient and painless state of this type of foot prior to the onset of symptoms. Subsequent care seems to require merely conservative measures.

POMERANZ, MAURICE M. Endotheliomata of bone. *J. Bone & Joint Surg.*, July, 1927, ix, 524–530.

Three cases of endothelioma of the bone are reported and in the detailed histories particular emphasis is placed on the similarity between endothelioma and osteomyelitis. Of the three cases, one was erroneously interpreted from the roentgenogram, one was correctly interpreted on first examination, and the third was suspected on the first examination. In all cases the clinical diagnosis was wrong, and in one it was suspected only after re-examination at a subsequent date. In the two cases roentgenographically suspected or diagnosed, the pathological section demonstrated a typical tumor. In the case positively diagnosed roentgenographically, the differentiation between tumor and inflammation was extremely difficult in the microscopic examination.

RIST, E., JACOB, P. and SOULAS, A. Extrinsic bronchial stenosis revealed by roentgenologic examination after injection of lipiodol under control of the bronchoscope. *Bull. et mém. Soc. méd. d hôp. de Par.*, 1926, l, 1082–1085.

Sergent and Cottenot have listed five conditions in which the use of lipiodol and the roentgenogram will show conditions in the lung: (1) deviations of the trachea and bronchi; (2) modifications of the permeability of the bronchial region; (3) dilatation of the bronchi; (4) pulmonary cavities, and (5) bronchial fistulas. To this list the authors have added another (6) bronchial stenosis. By injection of lipiodol directly into the bronchus under control of the bronchoscope, followed with the roentgenogram stenosis can be readily detected. A case report is given in which this technique was used with success.

ROBERTSON, D. E. Acute haematogenous osteomyelitis. *J. Bone & Joint Surg.*, January, 1927, ix, 8-23.

The vital factors concerning this disease are not fully recognized by the medical profession. The disease has for long been regarded as actually what its name implies but the early signs are not to be found in the middle of the shaft. The disease is so common, the symptoms so typical and the examination so definite that one is surprised that the diagnosis is ever missed. The signs and symptoms all point to the seat of infection being in the metaphysis.

Experimental work has proven beyond a doubt that (1) organisms introduced into the blood stream are deposited, among other places, in the long bones; (2) in bone there is very active phagocytosis except in the metaphyses; (3) organisms produce inflammatory centers in the metaphysis independent of trauma; (4) it is impossible to produce a general infection of the medulla by a simple inoculation of organisms into the blood stream; (5) trauma may determine a local infection; (6) growing bones develop abscesses of the type of osteomyelitis within them. Adult bones do so but rarely. In the presence of a bacteriemia, these abscesses may produce an arthritis in adults.

In human cases, the staphylococcal infections come from skin lesions by contaminations of the blood; and the primary bone lesion is determined by trauma. Continued septicemia favors the formation of supplementary bone lesions. In the case of the growing child the bone lesion is found in the metaphysis. The chief symptom is pain; the chief sign is tenderness over the involved metaphysis. Roentgenology has nothing to offer in the elucidation of an early diagnosis. The roentgenogram will not show anything of a definite nature until there is rarefaction of the bone, and this is not definite for days. A roentgenogram taken in the first days may give the uninitiated a very lamentable feeling of false security.

The treatment of acute hematogenous osteomyelitis consists of early operation into the metaphysis for purposes of drainage.

SCHOOLFIELD, BEN L. Report of a case of epiphyseal separation of the ischium. *J. Bone & Joint Surg.*, July, 1927, ix, 498–500.

The patient was a schoolboy eight years of age. The trouble had begun ten months pre-

viously, following a fall, with a pain in the right hip and knee and slight swelling of the corresponding knee and ankle. The patient was unable to walk for any considerable distance without much pain or fatigue. The roentgenogram showed that the ischium on the right side had been pushed inward and was encroaching to a considerable extent on the pelvic cavity. The ilium and pubis appeared to be approximately in their normal relationships. The acetabulum appeared roughened and a gap showing above the head of the femur indicated a part of the space from which the ischium had been displaced. The head of the femur was somewhat flattened and its neck thickened. The angle between the neck and shaft of the femur was considerably increased so that the shaft and neck formed something nearly approximating a straight line. The appearance of the head and neck of the femur on the right side was quite like that of the condition variously denominated as Legg's, Calvé's and Perthes' disease.

The displacement of the ischium was corrected in two stages. At the first sitting the flexion deformity was overcome by forcible stretching; and at the second sitting two months later the limb was forced into full abduction and another plaster-of-Pars spica was applied. The roentgenogram made following this latter manipulation showed a perfect alignment of the ischium with the rest of the innominate bone. Subsequent roentgenograms showed a gradual increase in the consolidation of the ischium with the other bones entering into the acetabulum.

Sicard, Robineau and Lichtwitz. Pseudocalculous roentgenographic shadows symptomatic of a pelvi-peritoneal tuberculosis. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, I, 127–129.

A woman thirty-five years of age suffering from pain in the lumbar region and right leg, in good health otherwise, showed on roentgenographic examination definite shadows which appeared to be calculi in the region of the lower vertebrae. These images were not typical of dermoid cysts of the ovary nor of calcified fibroma. Surgical operation revealed peritoneal granulations and small caseous abscesses. Histological examination confirmed these as tuberculous. These observations are of importance because the images were misleading and because of the interesting finding after operation.

Spurling, Roy G., and Whitaker, Lester R. End-results of cholecystostomy as shown by the cholecystogram. *Surg., Gynec. & Obst.*, 1927, xliv, 463–467.

Cholecystograms were made on 12 patients at varying intervals following cholecystostomy. Not one of them showed a normally functioning gall-bladder as demonstrated by the cholecystogram. Six of the patients experienced a return of symptoms severe enough to necessitate surgical relief. Four of these showed a recurrence of gallstones at operation; the remaining 2 showed fibrosis and thickening of the gall-bladder wall, the microscopic diagnosis in all cases being chronic cholecystitis.

Laboratory experiments were undertaken to study the effect of different types of injury to the gall-bladder upon subsequent cholecystograms and thus to obtain further evidence as to the significance of the findings in those patients in whom no operation was performed. It was found that a severely damaged mucosa prevented shadow formation, and that injury to the musculature of the gall-bladder inhibited emptying after the ingestion of fat, the conditions being as nearly comparable as they could be made to the cholecystic disease in the patients not subjected to operation.

It is concluded that apparently the drainage of a diseased gall-bladder with the expectation that it will regain its normal function is not only a futile procedure but one that endangers the future health of the patient.

ROENTGEN AND RADIUM THERAPY

Boidin, L., Darbois, Thevenard and Davoigneau. Multiple osseous myeloma (myeloblastic sarcoma). Roentgenotherapy. Healing maintained for sixteen months. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, I, 807–815.

This is a case in which myeloblastic sarcoma in the head responded remarkably to roentgenotherapy. There were two large tumors on the head which were ulcerated and infected to an extent that there was a very large hole in the skull. There was some improvement even after the first treatment with the roentgen ray. The hole formed by the tumor was later sealed by an osseous sheet and the destruction repaired. The case is interesting from three points of view: (1) diagnosis of the medullary nature of the osseous tumor; (2) the remarkable action of the roentgenotherapy, and (3) the repair of the extensive damage. The tumors were very large, being 10 cm. thick and 47 cm. circumference at the base. General physical and mental condition good, good appetite and digestion, no albumin in the urine, no polyuria, no sugar in urine, no albumin in blood; urea,

uric acid, phosphates normal; general health good. In the roentgen treatment, the coil of Robiquet was used; 25 cm. spark, filtration through 6 mm. of aluminum, distance 30 to 50 cm. At each point treated only 500 to 1000 R were given each time, repeated every eight days in the beginning and then every fifteen days. Irradiation was directed to the neoplasm prominently involved. By the use of small doses the chances of intoxication were lessened and the reconstruction of tissue favored. This treatment was continued at intervals for sixteen months, even after the disappearance of the tumors. The disappearance of the tumor was rapid, but the reconstruction of the bony structures required many months. There was no change in the blood picture during treatment; no anemia, no change in the proportion of leucocytes. The recovery was uneventful under the treatment as given, and it is considered important that the weak doses of the roentgen ray were more desirable than stronger treatment.

BURROWS, ARTHUR. Note on the treatment of recurrent endothelioma of the parotid gland. *Acta radiol.*, 1926, vi, 217–220.

All cases of mixed parotid tumors should be regarded as malignant. The experience at the Manchester District Radium Institute indicates that combined operation (enucleation) and radium therapy is an almost perfect method of treatment. The use of buried radium tubes alone is almost, if not quite, as good as the combined method. Excision of the tumor with the surrounding parotid tissue is the ideal operation but this may be difficult and it involves the risk of a parotid fistula and possible damage to a portion of the facial nerve. In the use of radium an application for twenty-four hours is long enough in the case of simple epitheliomas. Some of the cases have been under observation for at least six years and thus far no recurrences have taken place.

CAIN, ANDRE, SOLOMON and RACHET. Syndrome of intracranial hypertension without signs of localization and without meningeal reaction. Cure by deep roentgenotherapy. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1926, I, 958–963.

This case is reported in great detail because it illustrates the excellent results obtained by the use of roentgenotherapy in a serious case of intracranial hypertension. There were characteristic symptoms, headache, vertigo, vomiting, hypertension of the cerebrospinal fluid, etc., without any indication as to localization. Although the Wassermann test was negative, the patient was treated for syphilis because her father has suspicious lesions. There was no relief from such treatment, the symptoms continuing in unabated degree. Deep roentgenotherapy was resorted to, using the technique outlined by Solomon in his book on deep roentgenotherapy, which, briefly, is as follows: tension corresponding to 40 cm. spark, filtered through 0.5 mm. copper plus 2 mm. aluminum plus 1 cm. of wood; 3500 R was given to each field during the whole treatment (total for entire treatment), focal distance 30 cm., circumference of area irradiated 10 cm., three fields covering the occipital region and two fields covering the temporal region were treated. The total dose for thirteen days was 10,500 R. At first there was noticeable improvement (first three days); after the fifth day after the beginning of treatment definite amelioration of symptoms was noted. After five more days, this improvement was pronounced. In spite of this marked improvement the authors, considering the serious prognosis in the beginning, decided to give further treatment for syphilis. The general condition of the patient was good twenty-five days after the first treatments with the roentgen ray, and after two months from the beginning of treatment the distressing symptoms had entirely disappeared.

CHAMBERLAIN, W. E. Roentgen therapy with very small doses. *Acta radiol.*, 1926, vi, 271–280.

For a period of five years the routine treatment at Stanford Medical School for lymphadenitis, tuberculosis (except pulmonary), furunculosis and paronychia has consisted in local administration of 5 per cent of the erythema dose at weekly intervals. During the same period cases of leucemia have been treated by administering 10 per cent of the erythema dose to the region of the spleen at intervals varying from three days to four weeks. Recently Hodgkin's disease has been routinely treated by administering 5 per cent doses over very wide areas to practically the entire trunk at intervals varying from one to four weeks. This roentgen therapy with very small doses has been employed in the above conditions in 340 cases. Of these, 251 cases were followed up and the results are tabulated. A study of these cases suggests that the results are on the whole satisfactory and that very spectacular results are occasionally observed, possibly not obtainable with large doses.

COYON, AM., SOLOMON, I., and WILLEMIN. A cerebral tumor treated by roentgeno-

therapy. *Bull. et mem. Soc. méd. d. hôp. de Par.*, 1926, l, 955–958.

The case reported here showed symptoms of cerebral tumor which was confirmed by examinations by different physicians. The symptoms, which are given in detail, were those ordinarily associated with brain tumors. Irradiation was resorted to with the following technique: penetrating rays under a tension corresponding to a 40 cm. spark, filtered through 0.5 mm. of copper and 2 mm. aluminum and 2 cm. of wood. Two occipital fields and one temporal field were irradiated in a circle of 10 cm. diameter at a focal distance of 30 cm. A total dose of 3,500 R, measured ionometrically, was applied to each field, but the dose administered at each treatment was between 500 to 1,000 R. Treatments were given every two or three days. Erythema and pigment reactions were slightly apparent; however, there was complete falling out of the hair from the regions irradiated. After four treatments marked improvement was noted; the headache was less intense, vomiting ceased, and the patient partook of nourishment eagerly. The visual disturbances were much improved also. Twenty-one days after the beginning of treatments, the symptoms had entirely disappeared; the patient could walk normally and vision was normal; only a slight headache persisted. Ten days later the patient was discharged. Examination two months later showed continued good health and amelioration of all distressing symptoms.

The excellent results obtained by irradiation in this case cannot be expected in all cases of cerebral tumor. The authors are led to believe this case to be due to a glioma, for it is known that gliomas are more readily acted upon by the roentgen ray than certain other types of tumors. The interest in this case rests upon the excellent results secured with treatments with the roentgen ray alone without recourse to any other means.

Daland, Ernest M. Untreated cancer of the breast. *Surg., Gynec. & Obst.*, 1927, xliv, 264–268.

In order to determine the value of operative or radium therapy in cancer of the breast, study was made of 100 cases selected from the records of the Collis P. Huntington Hospital and the House of the Good Samaritan, Boston. Twenty-three of the cases were considered inoperable on first examination. None of these patients so far as could be learned had received any treatment for the cancer: either operation, radium or roentgen ray. Duration of life as computed from the time of the first symptom noted by the patient was 40.5 months on the average. The mean duration of the disease in these cases was thirty months, that is 50 patients were dead and 50 alive at the end of that time. The longest duration was found between the ages of sixty and sixty-four, the shortest between fifty-five and fifty-nine, except in one patient who was thirty-three years old.

The length of life in the untreated cases was compared with the length of life in two operative series. One group comprises 66 cases treated by radical operation, some of the cases also receiving postoperative roentgenization. This group was reported on by Dr. Greenough to the American Radium Society, Dallas, Texas, in 1926. In this group at the end of three years there were 60 per cent living without disease; at the end of five years 42 per cent, and at the end of seven years 35.5 per cent. The second group of treated cases included a selected group of 16 cases without involvement of the axillary glands. After three years 88 per cent were well; after five years 75 per cent and after seven years 62.5 per cent.

In the untreated series 40 per cent were alive at the end of three years; 22 per cent after five years; 9 per cent after seven years, and 5 per cent at the end of ten years. The last patients died thirteen years after their first symptom.

No definite relationship could be observed between previous pregnancies or diseases of the breast and the cancer. Lung or pleural metastasis was observed in 18 cases; involvement of the liver in 11 cases. Twenty-two per cent had swollen arms and these patients did not live quite as long as the average of the series. Fifteen per cent had bone metastasis and they lived slightly longer than the average. Microscopic study of the degree of malignancy failed to show any relationship between the length of life and the degree of malignancy. There was found no record of a case in which a cancer of the breast underwent spontaneous regression.

It is concluded that in studying the end-results of cases of cancer of the breast treated by operation or by other names, it must be remembered that many of the patients would have lived many years without such treatment. To compare treated and untreated cases both series must be studied in the same way, from the date of onset of the disease and not from the date of examination. The one factor which makes such a comparison impossible or unfair is that the patients in the one series are alive and well, while in the other they always have cancer.

DÖDERLEIN, ALBERT; DÖDERLEIN, GUSTAV; and VOLTZ, FRIEDRICH. Uterine carcinoma and its radiation treatment. *Acta radiol.*, 1926, vi, 335–360.

The radiological treatment of cancer of the uterus is a physical-biological problem. It is not advisable to regard cancer of the uterus as a biologically uniform disease process; on the contrary, its various forms have to be tested with respect to their reactivity toward radium and roentgen rays. The various forms of uterine cancer which are quite easily distinguishable from one another may be classified as follows:

A. Macroscopically:
   I. According to anatomical localization,
      (a) Carcinoma of the cervix uteri.
      (b) Carcinoma of the corpus uteri.
   II. According to the manner of growth.
      (a) Predominantly exstructive (cauliflower cancer).
      (b) Predominantly destructive growth.
      (c) Surface cancer.

B. Histologically:
   I. According to structure:
      (a) Primary solid carcinoma.
      (b) Primary glandular carcinoma.
      (c) Adenocarcinoma.
   II. According to the degree of histological maturity,
      (a) Well-matured squamous celled or adenocarcinoma.
      (b) Medium-matured squamous or adenocarcinoma.
      (c) Mature carcinoma without differentiation.

In addition attention must be paid to regressive metamorphoses as signs of low capacity for resistance of the carcinoma, to the number and forms of the mitoses and to the prevailing type of round cell infiltration in the stroma. Should a differential radiosensitivity of the several kinds of uterine cancer be found then perhaps a system of treatment individualized according to the morphological type might promise still further improvement in results.

The experience of the Women's Clinic of the University of Munich in 2,300 cases of cancer of the female genital organs shows that the radiological treatment of cancer is able to produce complete cure. Radiological treatment is superior to surgical treatment for it is successful in curing even inoperable cases. In comparing the results the quality of the material should be given greater consideration than heretofore. The result of the treatment is primarily dependent on the extension of the cancer. It cannot yet be stated with certainty whether the radiosensitivity is different in anatomically and biologically different carcinomas. Here the immature cancers proved more radiosensitive than the well matured ones. The factor which is very important for success is the complete carrying out of the treatment, in which the help of the house surgeon is absolutely necessary.

The dose of radioactive substance recommended is either 100 mg. radium bromide or mesothorium applied for twenty-four hours and repeated twice with intervening pauses of six weeks. Larger doses and longer intervals, or retreatment at shorter intervals are advised against strongly in order to avoid injuries.

The primary problem of research must be to take into account the varying radiosensitivity so as to permit individualization of the treatment to a greater degree.

FOVEAU DE COURMELLES. Roentgen rays and radium in gynecologic therapeutics. *Acta radiol.*, 1926, vi, 322–326.

In general the author prefers to use fractional doses and thereby avoids shock and too rapid absorption of toxic organic products. The roentgen therapy is given with 2 ma., 20 cm. spark for 15 to 30 minutes, according to the approximate age of the fibroma, one to three sittings per week for two to three weeks. A pause of one month is allowed and the treatment repeated. An aluminum filter is always used, the thickness varying from 2 to 10 mm., the corresponding spark gaps being from 20 to 40 cm. For cancer, each individual treatment is longer and the spark gap is increased to 30 to 40 cm., 2 ma., several portals of entry being employed. For radium therapy the author employs 20 to 30 mg. of radium bromide placed on each side of the neck of the uterus in the cul-de-sacs for a period of forty-eight hours, the dose being repeated two, three or four times.